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ABSTRACT

This curriculum guide is designed to assist industrial arts practitioners in improving instruction in the areas of energy and power technology. Included in the first part of the guide are a course flow chart, a course description, a discussion of target grade levels and prerequisites, course goals and objectives, an introduction, and a course outline. The next major section is a unit teaching guide consisting of units on the following topics: an introduction to power and energy; mechanical advantages; wind, water, solar, geothermal, electrical, fossil-fuel, nuclear, chemical, bioconversion, and wood energy; and electrical, mechanical, and fluid power. Appended to the guide are lists of abbreviations, definitions, and formulas; shop safety rules; a pulley-data table; exercises; puzzles; a directory of suppliers; sample test questions; a list of resource materials; and sample project and experiment sheets. (MN)

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VOCATIONAL EDUCATION

BULLETIN 1723

CURRICULUM GUIDE

CE035445

DEPARTMENT OF EDUCATION

THOMAS G. CLAUSEN
State Superintendent

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This public document was published at a total cost of $1.14; 1647 copies of this public document were published in this 1st printing at a cost of $1877. The total cost of all printings of this document, including reprints is $1877. This document was published by Louisiana Department of Education, Office of Vocational Education, Post Office Box 44064, Baton Rouge, Louisiana 70804 for the dissemination of vocational education curriculum materials for new and changing occupational fields under authority of Public Law 94-482. This material was printed in accordance with the standards for printing by state agencies established pursuant to R.S. 43:31.

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FOREWORD

This publication is a guide for the improvement of instruction in Industrial Arts Education for the State of Louisiana. It should be of benefit to industrial arts teachers, supervisors, counselors, and administrators. These operational guidelines will help local administrators, teacher educators, and industrial arts teachers determine the extent to which their programs are meeting the needs of our youth. Industrial Arts Education Programs must be organized to meet the needs of all students.

A constant concern for educators is the construction and revision of curriculum. Industry and technology are the core of industrial arts instruction. Both are constantly changing; therefore, a curriculum and instruction must change in order to provide students a realistic and accurate understanding of industry and its function in our complex technological society.

Thomas G. Clausen

Thomas G. Clausen
State Superintendent of Education

ACKNOWLEDGEMENTS

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Elaine Webb, Ed.D.
Assistant Superintendent
Office of Vocational Education

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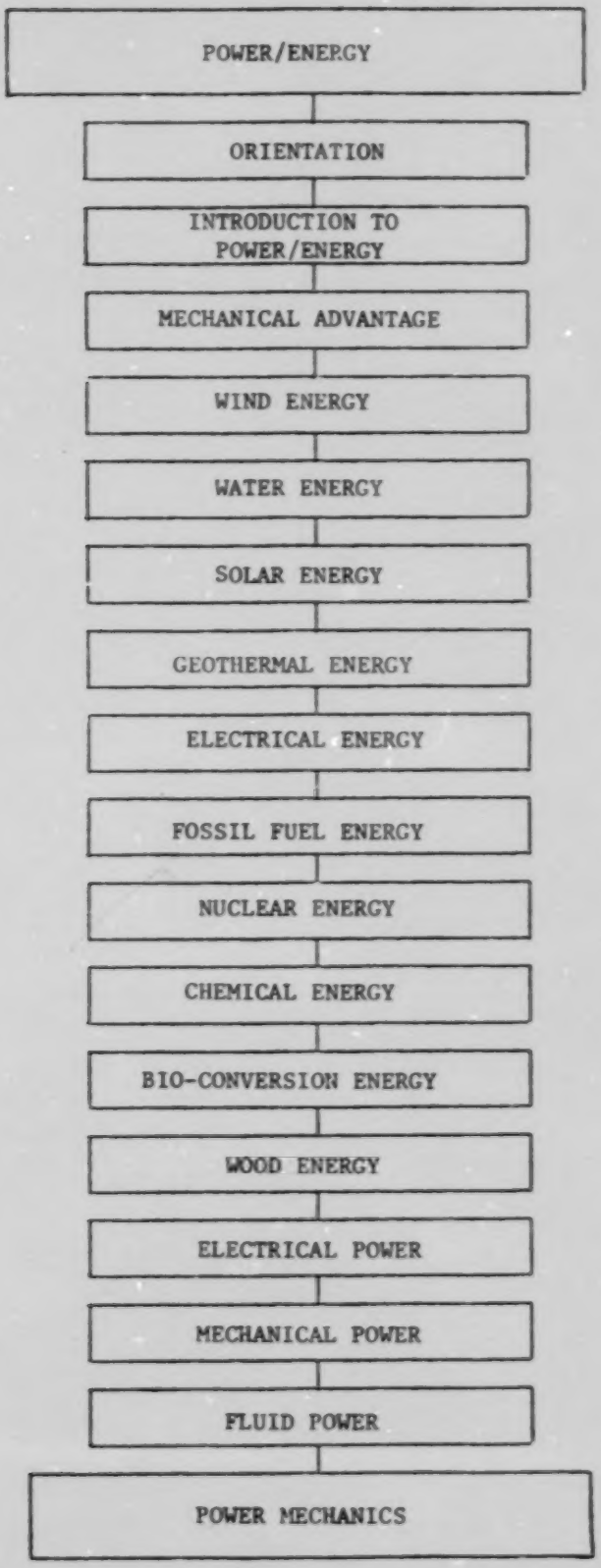
POWER/ENERGY
ORIENTATION
INTRODUCTION TO POWER/ENERGY
MECHANICAL ADVANTAGE
WIND ENERGY
WATER ENERGY
SOLAR ENERGY
GEOTHERMAL ENERGY
ELECTRICAL ENERGY
FOSSIL FUEL ENERGY
NUCLEAR ENERGY
CHEMICAL ENERGY
BIO-CONVERSION ENERGY
WOOD ENERGY
ELECTRICAL POWER
MECHANICAL POWER
FLUID POWER
POWER MECHANICS

Title:

Power/Energy

Course Description:

Power/Energy investigates all forms of energy and how energy can be converted to the three basic forms of power.

Target Grade Levels:

Grades 10 - 12

Prerequisite:

General Industrial Arts

Course Goals:

In this course, the student will become acquainted with the various energies and environmental problems connected with them. They will also be able to research, develop, explore, understand, and cope with alternate energy sources. The study of Power/Energy cannot be conducted in depth but should investigate the design and production of power systems and how they convert energy to useful work in society and industry.

Course Objectives:

To develop an awareness of the impact of Power/Energy on society.

To acquire an insight into the energy shortage and how it relates to society.

To acquaint the student with the various nonrenewable, renewable, and inexhaustible energy forms used today.

To understand the various energy sources and how they are used to produce usable power.

To comprehend the technological advances in power and energy.

To instill safe work habits.

To develop a degree of manipulative skills in the use of Power/Energy laboratory equipment and tools.

To become aware of design and production of power mechanisms and how they convert energy to useful work.

To increase understanding of the occupational requirements and opportunities in the Power/Energy fields.

To develop foundations and experiences in all areas of Power/Energy for advanced study.

Introduction:

Society is using our existing Power/Energy sources at such a tremendous rate that our existing resources could be exhausted in a generation. Looking toward the future we must develop and utilize chemical, mechanical, thermal, electrical, solar, and nuclear forms of energy.

By studying and experimenting with the various forms of Power/Energy as outlined in this course, students will have the opportunity to investigate a broad range of informational and practical applications relative to Power/Energy.

The students will be made aware of occupational opportunities through a variety of individually constructed projects, group projects, and classroom activities. In addition, analysis of employment trends, conservation of energy, pollution, environmental controls and the use of hand and power tools will be taught in this course.

Suggested Time Allotment:

The suggested time frame for Power/Energy is 174 days. The remaining 6 days are to be used as necessary for the opening and closing of the Power/Energy laboratory, school functions, and in units in which the instructor feels additional time is needed.

POWER/ENERGY

A COURSE OUTLINE

I. INTRODUCTION TO POWER/ENERGY

A. Forms of Energy

1. Potential
2. Kinetic

B. Sources of Energy

1. Inexhaustible
   a. Wind
   b. Water
   c. Solar
   d. Geothermal
2. Exhaustible
   a. Fossil fuel
   b. Nuclear
   c. Chemical
3. Renewable
   a. Bioconversion
   b. Wood

C. Forms of Power

1. Electrical
2. Mechanical
3. Fluid

D. Sources of Power

II. MECHANICAL ADVANTAGES

A. Simple Machines
   1. Lever/Fulcrum
      a. First class (crowbar)
      b. Second class (wheel barrow)
      c. Third class (baseball bat)
   2. Wheel/Axle
      a, Force (door knob)
      b. Distance (auto wheel)
   3. Pulley
      a. Fixed (window sash)
      b. Moveable (construction cable crane)
      c. Combination (block and tackle)

4. Inclined plane
    a. Upward (lifting device)
    b. Downward (gradual smooth descent)
5. Screw
    a. Transmits power (worm gear)
    b. Tightens (screw or bolt)
    c. Adjusts (faucet)
6. Wedge
    a. Divides (cutting)
    b. Raises (large objects)

B. Transmission Components

1. Cams
2. Gears
    a. Reverses direction
    b. Changes speed
    c. Changes power
    d. Changes shaft direction
3. Flat and V-belts
    a. Transmits power
    b. Changes rotation direction
    c. Changes shaft direction
4. Chains
    a. Non-slip power transmission
    b. Lack smoothness of operation
5. Clutches
    a. Engages and disengages power
    b. Transmits power from driver to shaft
6. Couplings
    a. Produces directional change
    b. Connects lengths of shafts
7. Bearings
    a. Reduces friction
    b. Supports rotating shafts
8. Brakes
    a. Stops moving load
    b. Regulates movement

III. WIND ENERGY

A. History and Background

1. Origin
    a. Phoenicians 3,000 B.C.
    b. Sailing with wind
2. Uses
    a. Improve sailing (tack)
    b. Wind mills
        (1) pump water
        (2) operate machinery
        (3) generate electricity (turbine)

B. Vocabulary

C. Present Uses

1. Pump water
2. Generate electricity
3. Heating

D. Mathematical Measurement

E. Environmental Effects

1. No detrimental effect
2. Advantages
   a. Non-depletive supply
   b. Independent of foreign sources

F. Future Trends

1. More productive turbines
2. Less expensive installation

G. Conservation

1. Wind channeling devices
2. Directional turbines

H. Careers

1. Semi-skilled
   a. Maintenance
   b. Laborer
2. Skilled
   a. Maintenance
   b. Sail maker
3. Technical
   a. Power station operator
   b. Electrician
4. Professional
   a. Engineer
   b. Scientist

IV: WATER ENERGY

A. History and Background

1. Origin 200 B.C.
   a. Egyptians
   b. Water wheel
   c. Water turbine
2. Uses
   a. Grinding grain
   b. Sawing wood
   c. Generating electricity

B. Vocabulary

C. Present Uses

1. Electricity power
2. Transportation
3. Irrigation

D. Mathematical Measurement

E. Environmental Effects

1. Flooding
2. Erosion
3. Heat discharge
4. Wildlife habitat

F. Future Trends

1. Harnessing tide power
2. Harnessing wave power

G. Conservation

1. Reforestation
2. Shower/bath
3. Bowl float

H. Careers

1. Semi-skilled
   a. Meter reader
   b. Gate tender
2. Skilled
   a. Plumber
   b. Mechanic
3. Technical
   a. Control operator
   b. Maintenance/repair
4. Professional
   a. Electrical engineer
   b. Scientist

V. SOLAR ENERGY

A. History and Background

1. Origin 215 B.C.
   a. Archimedes
   b. Burning the Roman fleet

2. Uses
   a. Solar pump (1600's)
   b. Solar furnace (1700's)

B. Vocabulary

C. Present Uses

1. Heating water
2. Heating homes
3. Desalinization
4. Generating electricity

D. Mathematical Measurement

E. Environmental Effect

1. Heating
2. Photosynthesis
3. Tides

F. Future Trends

1. Increasing dependency for electrical and heating needs
2. Transportation
3. Outerspace solar collector

G. Conservation

1. Storage as heat
2. Storage as electrical energy

H. Careers

1. Semi-skilled
   a. Window installer
   b. Insulation installer
2. Skilled
   a. Plumber
   b. Construction trade worker
3. Technical
   a. Heat/air conditioning repair person
   b. Optical technician
4. Professional
   a. Architect
   b. Researcher

VI. GEOTHERMAL ENERGY

A. History and Background

1. Origin (pre-historic man)
2. Uses
   a. Heating
   b. Cooking

B. Vocabulary

C. Present Uses

1. Heating
2. Generating electricity

D. Mathematical Measurements

E. Environmental Effect

1. Deep holes
2. Heat
3. Waste products
4. Unknown contaminants
5. High salt content

F. Future Trends

1. Increasing electrical generating output
2. Increasing heating efficiency

G. Conservation

H. Careers

1. Semi-skilled
   a. Truck driver
   b. Roughneck
2. Skilled
   a. Driller
   b. Plumber
3. Technical
   a. Pipe fitter
   b. Mud engineer
4. Professional
   a. Engineer
   b. Geologist

VII. ELECTRICAL ENERGY

A. History and Background

1. Origin - 600 B.C.
    a. Static electricity (Thales)
    b. Electrical theory (Franklin)
    c. Electrical current (Galvani)
2. Uses
    a. Demonstrations
    b. Light
    c. Batteries

B. Vocabulary

C. Present Uses

1. Lighting
2. Heating
3. Transportation
4. Communication

D. Mathematical Measurements

E. Environmental Effects

1. Lightning damage
2. Corneal effect
3. Ozone production

F. Future Trends

1. Harness lightning
2. Transportation
3. Fiber optics
4. Laser

G. Conservation

1. Use when needed
2. Produce when needed
3. Efficient storage
4. Energy/efficiency

H. Careers

1. Semi-skilled
    a. Appliance repair person
    b. Assembly line worker
2. Skilled
    a. Electrician
    b. Welder

3. Technical
   a. Radar repair person
   b. Communication worker
4. Professional
   a. Teacher
   b. Researcher

VIII. FOSSIL FUEL

A. History and Background

1. Origin
   a. Petroleum - 450 B.C.
   b. Coal - 300 B.C.
   c. Gas - 1667
2. Uses
   a. Heating
   b. Lightning
   c. Transportation

B. Vocabulary

C. Present Uses

1. Heating
2. Cooking
3. Transportation
4. Lightning
5. Electrical generation

D. Mathematical Measurements

E. Environmental Effect

1. Air pollution
2. Acid rain
3. Water pollution
4. Strip mining
5. Sludge pits

F. Future Trends

G. Conservation

1. More efficient structures
2. More efficient engines
3. Restoration of disturbed area

H. Careers

1. Semi-skilled

a. Gas station attendant
b. Truck driver
c. Miner
d. Roughneck

2. Skilled
   a. Rail engineer
   b. Refinery worker
   c. Pipe cutter
   d. Instrumentation worker

3. Technical
   a. Map maker
   b. Driller
   c. Mud logger

4. Professional
   a. Geologist
   b. Engineer

IX. NUCLEAR ENERGY

A. History and Background

1. Origin - 1920's
   a. Einstein--$E = MC^2$
   b. Fermi 1st sustained Nuclear reaction 1942

2. Uses
   a. Weapons
   b. Electrical power
   c. Research
   d. Medical

B. Vocabulary

C. Present Uses

1. Research
2. Material testing
3. Electric power generation
4. Medical uses
5. Industrial uses
6. Transportation

D. Mathematical Measurement

E. Environmental Effect

1. Radiation
2. Fallout
3. Spills
4. Waste storage

F. Future Trends

1. Safer reactors
2. Medical advances
3. Industrial
4. Transportation
5. Space exploration

G. Conservation

1. Recycling of radioactive material
2. Regeneration of plutonium

H. Career

1. Semi-skilled
   a. Waste treatment operator
   b. Security guard
2. Skilled
   a. Plumber
   b. Welder
3. Technical
   a. Inspector
   b. Reactor operator
4. Professional
   a. Chemist
   b. Physicist
   c. Scientist

X. CHEMICAL ENERGY

A. History and Background

1. Origin - 1600 B.C.
   a. Mesopotamia
   b. China
2. Use
   a. Alcohol fermentation
   b. Explosives

B. Vocabulary

C. Present Uses

1. Transportation
2. Heating
3. Explosives
4. Electrical generation
5. Fuel cells

D. Mathematics and Measurement 19

E. Environmental Effects

1. Water pollution
2. Air pollution
3. Land pollution

F. Future Trends

1. Warfare
2. Transportation

G. Conservation

H. Career

1. Semi-skilled
   a. Miner
   b, Material handler
2. Skilled
   a. Electrician
   b. Mechanic
3. Technical
   a. Chemical technician
   b. Plant manager
4. Professional
   a. Chemist
   b. Research and development scientist

XI. BIO-CONVERSION ENERGY

A. History and Background

1. Origin--late 1960's
2. Thirty plants on-line, starting up, or under construction
3. Most less than 10 years old

B. Vocabulary

C. Present Uses

1. Alcohol fuel for cars
2. Sales of solid waste for fuel
3. Sales of steam
4. Sales of gas for fuel

D. Mathematical Measurements

E. Environmental Effects

1. Reduction in volumes of garbage

2. Cleaner burning fuels
3. Less air pollution from rotting garbage
4. Thermal pollution

F. Future Trends

1. Increase efficiency, uses and profit
2. Increase consumption (Brazil's auto fleet)

G. Conservation

1. Use garbage to best efficiency
2. Have less final garbage volume
3. Use more recycling

H. Career

1. Semi-skilled
   a. Garbage collector
   b. Custodian
   c. Gas pump operator
2. Skilled
   a. Welder
   b. Pipefitter
   c. Draftsman
3. Technical
   a. Operators
   b. Plant manager
4. Professional
   a. Engineer
   b. Scientist
   c. Chemist

XII. WOOD ENERGY

A. History and Background

1. Origin primitive man
2. Uses
   a. Transportation
   b. Heat
   c. Light
   d. Weapons

B. Vocabulary

C. Present Uses

1. Transportation
2. Charcoal
3. Heat
4. Light

D. Mathematical Measurements

E. Environmental Effects

1. Erosion of soil
2. Air pollution (incomplete burning)
3. Aesthetic beauty
4. Fewer natural plants to aid in gas absorption and oxygen generation

F. Future Trends

1. Use more wood in industry as fuel
2. Use more wood for home heating
3. Eliminate waste

G. Conservation

1. Insulation
2. Better heat exchange
3. Better regulation of heat
4. Forest management

H. Career

1. Semi-skilled
   a. Lumber stacker
   b. Logger
2. Skilled
   a. Lumber grader
   b. Crane operator
3. Technician
   a. Plant superintendent
   b. Electrician
4. Professional
   a. Chemist
   b. Horticulturist

XIII. ELECTRICAL POWER

A. Development

1. Electrical power generation - Feraday
2. Light bulb - Edison - 1879
3. First Central Electric Station - N.Y.C. - 1882
4. Steam powered generators - produces most of of today's electrical power
5. Micro circuitry
6. Micro chip

B. Future Trends

1. More efficient usage
2. Sodium-sulphur battery cells
3. Aerospace
4. Transportation
5. Research

C. Advantages

1. Clean
2. Unlimited usage
3. Easy to transmit
4. Speed of transmission

D. Disadvantages

1. Network of transmission lines
2. Potentially dangerous
3. Voltage drop (over a distance)
4. Storage not efficient
5. Production cost
6. Power failure

E. Vocabulary

XIV: MECHANICAL POWER

A. Development

1. Muscle powered machines
   a. Crank
   b. Treadle
   c. Treadmill
   d. Bow
2. Steam powered machines
   a. Fulton's Steamboat - 1807
   b. Kempelen and Treuithicks Steam Turbine - 1815
   c. Cooper's Steam Locomotive - 1830
3. Internal combustion powered machines
   a. Aaimler's Gasoline Engine - 1885
   b. Duryear's Automobile - 1893
   c. Wright Bros: Heavier than air Flight - 1907
4. Rocket development - 1920's
5. Jet propulsion - 1940's

B. Future Trends

1. Robotics
2. Aerospace
3. Transportation

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C. Advantages

1. Durability
2. Multiplies force
3. Precision
4. Adaptability
5. Energy/cost efficiency

D. Disadvantages

1. Bulky equipment
2. Complex construction
3. Oxidation

E. Vocabulary

XV FLUID POWER

A. Development

1. Irrigation - Egypt
2. Plumbing systems - Crete
3. Science of hydraulics- Pascal - 1600's
4. Workable hydraulic press - 1795
5. Hydraulic accumulator - 1850
6. Variable stroke pump - 1875

B. Today's Uses

1. Brake systems
2. Lifting devices
3. Power tools
4. Heavy equipment
5. Transportation

C. Future Uses

1. Robotics
2. Aerospace
3. Manufacturing

D. Advantages

1. Easy power transmission
2. No lubrication
3. Smooth constant motion
4. Accurate control

E. Disadvantages

1. Rust and corrosion
2. Water separation
3. Form formation

F. Vocabulary

ORIENTATION: RULES, REGULATIONS, AND SAFETY 2 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit, the student will be able to identify the State, parish, school, and room rules and regulations, (including basic safety rules) that apply to the Power/ Energy lab.	State Rules Parish Rules School Rules Classroom Rules (including basic safety)	Read and sign rules and regulations handout sheet.	Discuss the various rules and regulations that apply to your particular situation. Make handout sheets for students to read and sign, including general rules, regulations, and basic safety rules.	State Handbook Parish Handbook School Handbook

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UNIT I: INTRODUCTION TO POWER/ENERGY 2 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit, the student will be able to: Differentiate between potential and kinetic energy.	A. Forms of Energy 1. Potential 2. Kinetic		Demonstrate the two forms of energy.	Book 12, p.27
Compute formulas dealing with potential and kinetic energy		Work potential and kinetic energy formulas.		Appendix "3"
Identify the three basic categories of energy sources.	B. Sources of Energy 1. Inexhaustible a. wind b. water c. solar d. geothermal 2. Exhaustible a. fossil fuel b. nuclear c. chemical 3. Renewable a. bioconversion b. wood	List examples of how various energy sources are being utilized.	Display A-V material depicting the various sources of energy. Construct a bulletin board showing the various sources of energy.	National Geographic Popular Science Popular Mechanics
List and describe the three forms of power.	C. Forms of Power 1. Electrical 2. Mechanical 3. Fluid	Give examples of where these power forms can be observed.		
Work Power/Energy problems.	D. Sources of Power Power is the rate of doing work. $\text{Power} = \frac{\text{Work}}{\text{Time}}$ By multiplying each side of this equation by T, we can write down another important relationship: Work done by a body (which equals the energy given up by the body in doing the work) is equal to the power generated times the	Work Power/Energy problems	Film/Filmstrip	See Appendix "3" See Appendix "8" for listing.

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UNIT I: INTRODUCTION TO POWER/ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	time needed to do the work. Work = Energy = Power x Time Thus - all energy sources can be transformed into any of the three forms of power.	Test - Power/Energy	Construct test.	

UNIT II: MECHANICAL ADVANTAGES 11 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will be able to:	A. Simple Machines 1. Lever/Fulcrum a. 1st class (crowbar) b. 2nd class (wheel barrow) c. 3rd class (baseball bat)	Experiment with various lever/fulcrum combinations.	Lecture/demonstration. Display examples of the three lever classifications.	Book 13, p. 5 Book 20, p. 5 Book 20b, pp.6,8,10 Book 15, p. 214 See Appendix "15" p 111
List the six simple machines. Become familiar with the parts and uses of the lever/fulcrum.				
Describe the advantages of a wheel and axle.	2. Wheel/Axle a. force (door knob) b. distance	Compute distance per rotation. Differences with various size wheels. Example - (bicycle wheels)	Demonstrate formula for circumference.	See Appendix "3" Book 20, p. 7 Book 15, p. 216
Recognize the three different types of pulley arrangements.	3. Pulley a. fixed (window sash) b. movable (construction cable crane) c. combinations (block and tackle)	Experiment with various pulley combinations and describe the mechanical advantage of each. Fill out pulley data table.	Accumulate materials necessary for pulley assemblies. Hand out pulley data table.	Book 20, p.8 Book 20b, pp.13-15 See Appendix "5" and 15 p 103
Know the advantages of an inclined plane.	4. Inclined plane a. upward (lifting device) b. downward (gradual smooth descent)			Book 20, p.9 Book 15, p.219
Describe the three functions of a screw.	5. Screw a. transmits power (worm gear) b. tightens (screw or bolt) c. adjusts (faucet)	List examples of the three functions of the screw.	Demonstrate the different screw functions.	Book 20, p.10 Book 15, p.220
Understand the two functions of the wedge.	6. Wedge a. divides (cutting) b. raises (large objects)		Demonstrate splitting a log. Demonstrate raising an object.	Book 20, p.10 Book 15, p.219
List the eight basic transmission components.	B. Transmission Components 1. Cams		Make display of a cam and follower.	Book 13, p.469 Book 15, p.223
Understand the function of each basic transmission component.	2. Gears a. reverses direction b. changes speed c. changes power d. changes shaft direction	Identify and explain modern applications of the basic transmission components. Cut-away standard transmission.	Show cut-away of standard transmission.	Book 13, p. 441 Book 15, p. 224 Book 20b, p. 107

UNIT II: MECHANICAL ADVANTAGES (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	3. Flat and V-belts a. transmits power b. changes rotation direction c. changes shaft direction		Demonstrate with rubber band and shafts (dowel, pencil, etc.)	Book 13, p.435 Book 15, p.278
	4. Chains a. non-slip power transmission b. lacks smoothness of operation			
	5. Clutches a. engages and disengages power b. transmits power from driver to shaft	Research and report on various transmission components.	Construct and show a transparency overlay depicting clutch operation.	Book 13, p.452 Book 15, p.230
	6. Couplings a. produces directional change b. connects lengths of shafts		Use universal joint as an example.	Book 13, p.429 Book 15, p.236
	7. Bearings a. reduces friction b. supports rotating shafts	List five places bearings are used on a bicycle.	Demonstrate with a wheel bearing.	Book 13, p.432 Book 15, p.237
	8. Brakes a. stops moving load b. regulates movement		Demonstrate with an auto rear brake plate and assembly. Present film/filmstrip.	Book 13, p.459 Book 20b, p.231 See Appendix "8"
		Test - Mechanical advantages	Construct test.	
			At the teacher's discretion, combinations of various simple machines and transmission components may be used to create more complex machines.	

UNIT III: WIND ENERGY 10 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will:	A. History and Background 1. Origin a. Phoenicians 3000 BC b. sailing with wind 2. Uses a. improved sailing (tack) b. windmills (1) pump water (2) operate machinery (3) generate electricity (turbine)			
Be exposed to historical information concerning wind energy.		Construct a Fayoum boat (individual project)	Use visual aids to reinforce lecture/demonstration.	Book 20, p.29 Book 12b, p.14 (plans)
		Construct a simple windmill using straws, paper, glue, etc. (individual project)	Assist with the construction of a simple windmill	
Be able to correctly use the vocabulary words associated with wind energy.	B. Vocabulary	Define the following vocabulary words: anemometer, air foil, rotor, vertical axis, yaw, wind tunnel, pitch, fantail, rudder, upwind, governor, reciprocating, W.E.C.S.	Hand out vocabulary sheet.	See Glossary.
		Complete word puzzle	Construct word puzzle.	
Be able to understand the principles of electrical power generated by wind energy.	C. Present Uses 1. Pump water 2. Generate electricity 3. Heating	Construct a wind driven generator using a bicycle generator (group project).	Discuss and assist with the construction of a wind powered generator.	Book 12, p.175 P.S. 10, March 76, pp. 73-75 P.S. 10, Jan. 78, p. 89 P.S. 10, Nov. 77, p. 62
Be able to work with mathematical formulas relating to wind energy.	D. Mathematical Measurement	Construct a wind velocity meter (individual project). Have students record wind speed measurements and calculate MPH for a 30 day period.	Review formulas relating to wind energy. Assign problems.	See Appendix "6" Book 3, p.118 Book 3, p.119 Book 12b, p.77 (plans)
		Construct a simple weathervane (individual project)	Hand out wind speed measurement sheets.	See Appendix "6"

UNIT III: WIND ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Recognize the effects of wind energy on our environment.	E. Environmental Effects 1. No detrimental effect 2. Advantages a. non-depletive supply b. independent of foreign sources		Display models or pictures of futuristic wind machines.	PS 10, Sept. 78, p.70 PM 7, May 78 p. 116
Be able to apply the principles of generating electrical current through the construction of a wind turbine.	F. Future Trends 1. More productive turbine 2. Less expensive installation	Construct wind turbine (group project).		Book 20b, pp.31-35 (plans)
Be made aware of conservation efforts in the area of wind energy.	G. Conservation 1. Wind channeling devices 2. Directional turbines	(Optional) Construct wind tunnel.	Using a megaphone and fan, demonstrate wind channeling. Demonstrate the benefits of directional turbines.	Book 20b, pp.37-41 PS 10, Jan.77, pp.60-61 Book 21, pp.22,36
Be made aware of the various careers available in the wind energy field.	H. Careers 1. Semi-skilled a. maintenance worker b. laborer 2. Skilled a. mechanic b. sail maker 3. Technical a. power station operator b. electrician 4. Professional a. engineer b. scientist		Have personnel from local industry discuss careers related to wind energy.	Occupational Outlook Handbook
			Present film/filmstrip.	See Appendix "8" for listing.
		Test - Wind Energy	Construct Test.	

UNIT IV: WATER ENERGY 7 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will:	A. History and Background 1. Origin 299 BC a. Egyptians b. water wheel c. water turbine 2. Uses a. grinding grain b. sawing wood c. generating electricity		Use visual aids to reinforce lecture/demonstration.	Book 13, p.9 Book 20, p.13 Book 13, p.11 Book 20, p.15
		Construct water wheel to make electrical power (group project).	Help students construct a water wheel.	IE 9, Feb. 78,p.42 (plans)
Be able to correctly use the vocabulary words associated with water energy.	B. Vocabulary	Define the following vocabulary words: sedimentation, undershot, overshot, H_2O, hydrocarbons, biodegradable, particulates,reservoir, hydroelectric, flowrate, sea level. Complete word puzzle.	Hand out vocabulary sheet. Construct word puzzle.	See Glossary Book 13, p.9
Understand the basic operating principles of the water turbine.	C. Present Uses 1. Electrical power 2. Transportation 3. Irrigation	Construct water turbine (group project).	Assist with construction of water turbine.	Book 20, p.14 Book 20b, pp.21-26
Be able to work with mathematical formulas relating to water energy.	D. Mathematical Measurement	Complete problems	Review formulas relating to water energy. Assign problems	See Appendix "3"
Recognize the effects of water energy on our environment.	E. Environmental Effects 1. Flooding 2. Erosion 3. Heat discharge 4. Wildlife habitat	Report on various water hazards on the environment.		
Be introduced to some of the future trends of water energy.	F. Future Trends 1. Harnessing tide power 2. Harnessing wave power			PM 7, Nov.75,p.93 Book 24, p.263 Book 15, p.23 PS 10, Nov.77, p.16 PS 10, May 79, p.74 PM 7, March,77,p.192

UNIT IV: WATER ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Be made aware of the conservation efforts being made in the area of water energy.	G. Conservation 1. Reforestation 2. Shower/bath 3. Bowl float	Conduct bath/shower experiment.	Have speaker from Forestry, Farm Bureau, or Conservation. Group discuss water's effect on the environment.	See Appendix "7" Book 21, p.122
Be knowledgeable of the various careers available in the water energy field.	H. Careers 1. Semi-skilled a. meter reader b. gate tender 2. Skilled a. plumber b. mechanic 3. Technical a. control operator b. maintenance/repair 4. Professional a. electrical engineer b. scientist		Obtain speaker from Army Corps of Engineers, Water Works, to discuss careers related to water energy.	Occupational Outlcok Handbook
			Present film/filmstrip.	See Appendix "8" for listing
		Test - Water Energy	Construct test.	

UNIT V: SOLAR ENERGY 15 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will:	A. History and Background 1. Origin 215 B.C. a. Archimedes b. Burning of Roman Fleet		Lecture/demonstration.	
Be exposed to historical information concerning solar energy.	2. Uses a. Solar pump (1600's) b. Solar Furnace (1700's)	Construct a model of solar furnace	Assist with the construction of the model.	Book 12b, p.82 (plan) Book 24, p.200
Be able to correctly use the vocabulary words associated with solar energy.	B. Vocabulary	Define the following vocabulary words: collector, heat pump, photo-electric, parabolic, kilowatt, solar cell, absorbers, thermosyphining, conduction, convection, radiation, photovoltaic, photogalvanic, silicon, thermodynamic.	Pass out vocabulary sheet.	See Glossary HM 12, May/June 81 p. 8
	C. Present Uses 1. Heating water 2. Heating home 3. Desalinazation 4. Generating electricity	Complete word puzzle	Construct word puzzle. Design bulletin board depicting present usage of solar energy.	PS 10,June 78, p.58 PS 10, July 78,p.72 PS 10, Jan 79, pp. 46 & 58 PS 10, May 76,p. 99 Book 24, p.188 PS 10,Dec. 77,p. 80
		Construct a solar battery charger	Demonstrate and assist student in construction of solar battery.	See Appendix "15", p 115
		Construct a solar flat plate (group)	Assist in construction of solar flat plate.	IE 9, April 79, p.48 (plans) Appendix "15",p 113 Appendix "3"
Be able to work mathematical formulas relating to solar energy.	D. Mathematical measurements	Complete problems. Construct solar cell test stand (group project). Construct shadow plotter.	Review formulas relating to solar energy. Assign problems. Assist with construction of test stand. Assist with construction of plotter.	Book 12b, p.81(plans) PS Nov. 79, p.144 (plans)

UNIT V: SOLAR ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Recognize the effects of solar energy on our environment.	E. Environmental Effects 1. Heating 2. Photosynthesis 3. Tides	Construct solar cooker.	Assist students with construction	Book 3, p.162 (plans) See Appendix "15", p 117
	F. Future Trends 1. Increasing dependency for electrical and heating needs 2. Transportation 3. Outerspace solar collector	Construct solar powered radio (group project).	Assist with construction of radio.	PS 10, July 76,p. 48 PS 10, Aug.79, p.22 (plans) PM 7, Sept. 78, p.77
Be made aware of the conservation efforts being made in the area of solar energy.	G. Conservation 1. Storage of heat 2. Storage as electrical energy			Book 21, pp. 52,56
Be knowledgeable of the various careers available in the solar energy field.	H. Careers 1. Semi-skilled a. window installer b. insulation installer 2. Skilled a. plumber b. construction trade worker 3. Technical a. heat/air conditioning repair b. optical technician 4. Professional a. architect b. researcher	Contact,by writing, one of the industries listed in Appendix 10 for information on careers in solar energy.	Obtain local power company representatives to discuss occupations. Collect and mail students' letters.	Occupational Outlook Handbook. Appendix "10"
			Present film/filmstrip.	See Appendix "8" for listing.
		Test - Solar Energy	Construct Test.	

UNIT VI: GEO-THERMAL ENERGY 5 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit, the student will:	A. History and Background 1. Origin(pre-historic man) 2. Uses a. heating b. cooking		Lecture/Demonstration	Book 24, p.272
Be exposed to historical information concerning Geothermal Energy.				
Be able to correctly use the vocabulary words associated with Geothermal energy.	B. Vocabulary	Define the following vocabulary words: magma, geyser, porous, surface water, steam, fissured rock, geothermal contaminants, condenser, water flash. Complete word puzzle	Hand out vocabulary sheets Construct word puzzle	See Glossary
	C. Present Uses 1. Heating 2. Generating electricity	Construct a small display showing a schematic representation of geothermal operation (model, poster board, etc.)		Book 15, p.25 PS 10, Feb. 79, p.67 Book 24, p.273
Be able to work the mathematical formulas relating to Geothermal Energy.	D. Mathematical Measurements	Work assigned problems.	Review formulas relating to Geothermal energy. Assign problems.	Appendix "3"
Recognize the effects of Geothermal Energy on our environment.	E. Environmental Effect 1. Deep holes 2. Heat 3. Waste products 4. Unknown contaminants 5. High salt content		Have speaker from refineries, power plants, or any other industry using steam to discuss the effect of steam on the environment.	Book 15, p.59 PS, Feb. 79, p.69
	F. Future Trends 1. Increasing electrical generating output 2. Increase heating efficiency		Present film on Geothermal energy.	See Appendix "8" for listing. Book 24, p.273
Be made aware of the conservation efforts being made in the area of Geothermal energy.	G. Conservation			
Be knowledgeable of the various careers available in the Geothermal Energy field.	H. Careers			

UNIT VI: GEO-THERMAL ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	1. Semi-Skilled a. truck drivers b. roughnecks 2. Skilled a. drillers b. plumbers 3. Technical a. pipe fitters b. mud engineers 4. Professional a. engineers b. geologists			
		Test - Geothermal Energy	Construct test.	

UNIT VII: ELECTRICAL ENERGY 10 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit, the student will:	A. History and Background		Lecture/demonstration	Book 20, p.75
Be exposed to historical information concerning electrical energy.	1. Origin - 600 B.C. a. static electricity (Thales) b. electric theory (Franklin) c. electric current (Galvani)			
	2. Uses a. demonstrations b. light c. batteries	Cut away a dry cell battery and identify the parts. Construct a simple battery.		Book 12, p.164 Book 12, p.169
Be able to correctly use the vocabulary words associated with this unit.	B. Vocabulary	Define the following vocabulary words: magnetism, electrons, conductor, resistance, capacitor, static, circuit, generator, motor, AC, DC, battery, transformer, rectifier, polarity.	Pass out vocabulary sheets.	See Glossary.
		Complete word puzzle.	Construct word puzzle.	
	C. Present Uses 1. Lighting 2. Heating 3. Transportation 4. Communication	List current means of producing electrical energy. Construct electric motor.	Supervise construction of electrical motor.	Book 12b, p.75 Book 20b, p.57 IE 9, Oct.78, p.46
Be able to work mathematical formulas relating to electrical energy.	D. Mathematical Measurements		Review formulas relating to electrical energy. Demonstrate current generation within a lemon using a V.O.M.	See Appendix "15", p 109 See Appendix "3" IE 9, Oct. 78, p.46
		Work problems.	Assign problems.	Book 12, p.69.

UNIT VII: ELECTRICAL ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Recognize the effects of electrical energy on our environment.	E. Environmental Effects 1. Lightning damage 2. Cornea effect 3. Ozone production			
	F. Future Trends 1. Harness lightning 2. Transportation 3. Fiber optics 4. Laser			PM 7, Aug 83, p.55 Book 20, p.95 Book 20, p.102 Book 24, p.275
Be made aware of the conservation efforts being made in the area of electrical energy.	G. Conservation 1. Use when needed 2. Produce when needed 3. Efficient storage 4. Energy efficiency	List all electrical appliances in their home. Explain how each would be compensated for if there were no electrical energy.		Book 22, pp. 256,243 Book 21, pp. 106, 118, 146
Be knowledgeable of the various careers available in the electrical energy field.	H. Careers 1. Semi-skilled a. appliance repair b. assembly line 2. Skilled a. electricians b. welders 3. Technical a. radar repair b. communications workers 4. Professional a. teachers b. researchers			Occupational Outlook Handbook Book 20, p.101
			Present film/filmstrip	See Appendix "8" for listing.
		Test - Electrical Energy	Construct test	

UNIT VIII: FOSSIL FUEL ENERGY 10 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit, the student will:				
Be exposed to historical information concerning fossil fuel.	A. History and Background 1. Origin a. petroleum 450 B.C. b. coal 300 B.C. c. gas 1667 2. Uses a. heating b. lighting c. transportation		Lecture/demonstration.	Book 23, pp.29, 59, 48 Book 23, pp.41, 51, 53
Be able to correctly use the vocabulary words associated with this unit.	B. Vocabulary	Define the following vocabulary words: coke, decay, petroleum, lignite, anthracite, bituminous, shale, combustion, paraffin, hydrocarbon, turbulence, inflammability Complete word puzzle.	Pass out vocabulary sheet. Construct word puzzle.	See Glossary
	C. Present Uses 1. Heating 2. Cooking 3. Transportation 4. Lighting 5. Electrical generation	Obtain a different type of fossil fuel for each present use. (Example - gasoline, fuel oil, coal, etc.)	Collect the types of fossil fuels from students and make a display.	PS 10, June 77, p.34 Book 22, p.20 Book 15, p.12
Be able to work mathematical formulas relating to fossil fuels.	D. Mathematical Measurements	Complete problems.	Review formulas relating to fossil fuels. Assign problems.	See Appendix "3"
Recognize the effects of fossil fuels on our environment.	E. Environmental Effects 1. Air pollution 2. Acid rain 3. Water pollution 4. Strip mining 5. Sludge pits.	Burn two or three different types of fossil fuels and examine the visual environmental effects on each. (Example - smell, smoke, etc.)	Supervise students during the environmental effects experiment.	Book 15, pp.12,14 Book 13, p.401 Book 24, p.58

UNIT VIII: FOSSIL FUEL ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	F. Future Trends 1. Coal fired power plant 2. Research into more economical usages			PS 10, Aug.78, p.76 Book 15, p.12 Book 24, p.82
Be made aware of the conservation efforts being made in the area of fossil fuel use.	G. Conservation 1. More efficient structures 2. More efficient engines 3. Restoration of disturbed areas.	List the different ways to conserve fossil fuels (Example - drive 55 mph, shut dampers on grills, reduce temperature on thermostats)	Compile a master list of ways to conserve fossil fuels from the individual student lists with the help of the students.	PS 10, Oct.78, p.133 Book 22, p. 241 Book 21, pp. 118,130
Be knowledgeable of the various careers available in the fossil fuel field.	H. Careers 1. Semi-skilled a. gas station attendant b. truck driver c. miner d. roughneck 2. Skilled a. rail engineer b. refinery worker c. pipefitter d. instrumentation worker 3 Technical a. map maker b. driller c. mud logger 4. Professional a. geologist b. engineer		Have refinery engineers, geologists, or other professionals explain careers in the fossil fuel field.	Occupational Outlook Handbook
			Present film/filmstrip.	See Appendix "8" for listing.
		Test - Fossil Fuels	Construct test.	

UNIT IX: NUCLEAR ENERGY 10 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will:	A. History and Background 1. Origin - 1920's a. Einstein - $E=mc^2$ b. Fermi - 1st sustained nuclear reaction - 1942 2. Uses a. weapons b. electrical power c. research d. medical		Lecture/demonstration.	
Be exposed to historical information concerning nuclear energy.			Make a bulletin board on Einstein and his $E = MC^2$ formula.	Book 20, p.239
Be able to correctly use the vocabulary words associated with this unit.	B. Vocabulary	Define the following vocabulary words: radiation, fallout, reactor, fission, fusion, uranium, plutonium, thorium, isotope, core, fuel rod, plasma, chain reactor, thermocouple.	Pass out vocabulary sheets.	See Glossary
		Complete word puzzle.	Construct word puzzle.	
Understand the uses and needs of nuclear energy.	C. Present Uses 1. Research 2. Material testing 3. Electric power generation 4. Medical uses 5. Industrial uses 6. Transportation	Construct a chain reaction demonstration (group project).	Assist students in the construction of chain reaction demonstration.	Book 20b, p.121 (plans) Book 15, p.339 Book 20, p.252 Book 13, p.132 See Appendix "15", p 108
Be able to work mathematical formulas relating to nuclear energy.	D. Mathematical Measurements		Review formulas relating to nuclear energy.	Book 20, p.240 See Appendix "3"
		Complete problems.	Assign problems.	
Recognize the effects of nuclear energy on our environment.	E. Environmental Effects 1. Radiation 2. Fallout 3. Spills 4. Waste storage	Collect newspaper and magazine articles on nuclear energy pertaining to environment (spills, waste dumps, etc.).	Present film "Nuclear Power and The Environment."	PS 10, Dec 78, p.90 See Appendix "8" Book 15, p.343 Book 24, p.173

UNIT IX: NUCLEAR ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Expand his horizons on the future trends relating to nuclear energy.	F. Future Trends 1. Safer reactors 2. Medical advances 3. Industrial 4. Transportation 5. Space exploration	Identify the major parts of a nuclear power plant.	Present film "The fuel of the Future". Obtain scale plastic model of a nuclear power plant.	Book 13, p.139 See Appendix "8" Ex. Toys 'R' Us (Toy Stores) Book 20, p.256 Book 15, p.342
Be made aware of the conservation efforts being made in the area of nuclear energy.	G. Conservation 1. Recycling of radioactive materials 2. Regeneration of plutonium	Divide students into pro and con groups and have a debate on nuclear energy.	Monitor a debate on nuclear energy.	Book 15, pp.342,343 Book 13, p.136
Be knowledgeable of the various careers available in the nuclear energy field.	H. Careers 1. Semi-skilled a. waste treatment operator b. security guard 2. Skilled a. plumbers b. welders 3. Technical a. inspector b. reactor operator 4. Professional a. chemist b. physicist c. scientist	Make a list of questions to be asked the personnel director about obtaining a job and the benefits of working in a nuclear power plant.	Contact personnel director of the River Bend Nuclear Power Plant (Louisiana).	Occupational Outlook Handbook Book 20, p.258
			Present film/filmstrip	See Appendix "8" for listing
		Test - Nuclear Energy	Construct test	

UNIT X: CHEMICAL ENERGY 15 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will: Be exposed to historical information concerning chemical energy.	A. History and Background 1. Origin - 1600 B.C. a. Mesopotamia b. China 2. Uses a. alcohol fermentation b. explosives		Lecture/demonstration	Book 13, p.322 Book 20, p. 149
Be able to correctly use the vocabulary words associated with this unit.	B. Vocabulary	Define the following vocabulary words: acid, biochemist, synthetic, catalyst, compound, alkalies, formula, molecule, element, analysis, viscosity.	Pass out vocabulary sheets.	See Glossary
		Complete word puzzle.	Construct word puzzle.	
	C. Present Uses 1. Transportation 2. Heating 3. Explosives 4. Electrical generation 5. Fuel cells		Present film "Electricity From Chemicals".	See Appendix "8" Book 13, pp.364,411 Book 15, p.350 Book 12, p.205 PS 10, June 78, p.62
Be able to work mathematical formulas relating to chemical energy.	D. Mathematics and Measurements	Construct model rocket. Construct tracking device to determine rocket altitude. Compute data for rocket test information chart.	Assist with construction of rocket. Assist with construction of tracking device.	Book 12, p.155 Appendix "3" & "15",p 109 Appendix "12" Book 12, p.157 See Appendix "11"
		Complete problems.	Review formulas for nuclear energy. Assign problems.	
Recognize the effects of chemical energy on our environment.	E. Environmental Effects 1. Water pollution 2. Air pollution 3. Land pollution	Experiment with plants using different chemicals mixed with water. Sprinkle on plants. Watch the effect on plants over a time period.	Construct an experiment on plants with chemicals in water.	

UNIT X: CHEMICAL ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	F. Future Trends	Make a fuel cell (group project).	Obtain all necessary supplies and help in the construction of a fuel cell.	PS 10, March 77, p.84 Book 12b, p.87
Be made aware of the conservation efforts being made in the area of chemical energy.	G. Conservation			
Be knowledgeable of the various careers available in the chemical energy field.	H. Careers 1. Semi-skilled a. mining b. material handling 2. Skilled a. electrician b. mechanic 3. Technical-chemical technician 4. Professional a. chemist b. research and development scientist		Request local school chemistry teacher to talk to students on careers in the chemical industry.	Occupational Outlook Handbook
		Test - Electrical Energy	Construct test.	

UNIT XI: BIOCONVERSION ENERGY 7 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will: Be exposed to historical information concerning bioconversion energy.	A. History and Background 1. Origin - late 1960's 2. Thirty plants on-line, starting up, or under construction 3. Most less than 10 years old.		Lecture/demonstration	Book 21, p.142 Book 15, p.17 IE 9, Apr. 78, p.46
Be able to correctly use the vocabulary words associated with this unit.	B. Vocabulary	Define the following vocabulary words: hydrolysis, bacteria, pyrolysis, caloric value, fermentation, enzyme, anaerobic, petroleum equivalency, biochemistry, slurry, digester.	Pass out vocabulary sheets.	See Glossary
		Complete word puzzle.	Construct word puzzle.	
	C. Present Uses 1. Alcohol fuel for cars 2. Sales of solid waste for fuel 3. Sales of steam 4. Sales of gas for fuel	Construct a working digester to convert slurry to waste gas.	Assist students with construction of digester.	PS 10, Aug 77, pp.40,9 PM 7, Apr 77, p.46 National Geographic Apr 83, p. 434 IE 9, Apr 78, p.46 (plans)
Be able to work mathematical formulas relating to bioconversion.	D. Mathematical Measurements	Work problems.	Review formulas relating to bioconversion. Assign problems for work.	See Appendix "3" See Appendix "15", p 105
Recognize the effects of bioconversion on our environment.	E. Environmental Effects 1. Reduction in volumes of garbage 2. Cleaner burning fuels 3. Less air pollution from rotting garbage 4. Thermal pollution		Show film.	MI 8, Aug 83, p.71 "The Garbage Explosion-Saving the Environment" (Film) See Appendix "8"

UNIT XI: BIOCONVERSION ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	F. Future Trends 1. Increase efficiency, uses and profit 2. Increase consumption (Brazil's auto fleet)			PS 10, May 79, p.106 Book 24, p.239
Be made aware of the conservation efforts being made in the area of bioconversion.	G. Conservation 1. Use garbage to best efficiency 2. Have less final garbage volume 3. Use more recycling			MI 8, Aug 83, p.71 book 24, p.237
Be knowledgeable of the various careers available in the bioconversion field.	H. Careers 1. Semi-skilled a. garbage collectors b. custodians c. gas pump operators 2. Skilled a. welders b. pipefitters c. draftsmen 3. Technical a. operators b. plant managers 4. Professional a. engineers b. scientists c. chemists			Occupational Outlook Handbook
			Present film/filmstrip.	See Appendix "8" for listing
		Test - Bioconversion Energy	Construct test.	

UNIT XII: WOOD ENERGY 10 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will: Be exposed to historical information concerning wood energy.	A. History and Background 1. Origin - Primitive man 2. Uses a. transportation b. heat c. light		Lecture/demonstration	Book 24, pp.8,21,313
Be able to correctly use the vocabulary words associated with this unit.	B. Vocabulary	Define the following vocabulary words: softwood, hardwood, charcoal, combustion, resin, conifer, photosynthesis, fibrous, naval stores, ligneous	Pass out the vocabulary sheet.	See Glossary
		Complete word puzzle.	Construct word puzzle.	
	C. Present Uses 1. Transportation 2. Charcoal 3. Heat 4. Light	Conduct experiments with different brands of charcoal to ascertain which burns longer, lights fastest and heats quickest.		Book 24, pp.313,233
Be able to work mathematical problems relating to wood energy.	D. Mathematical Measurements	Compare the BTU ratings of various insulations.	Review formulas relating to wood energy.	See Appendix "3"
		Work problems.	Assign problems.	
Recognize the effects of wood energy on our environment.	D. Environmental Effects 1. Erosion of soil 2. Air pollution (incomplete burning) 3. Aesthetic beauty 4. Fewer natural plants to aid in gas absorption and oxygen generation.			

UNIT XII: WOOD ENERGY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	F. Future Trends 1. Use more wood in industry as fuel 2. Use more wood for home heating 3. Eliminate waste	Conduct experiments to determine the different burning characteristics of different types of wood.	Assist students with experiments.	Book 24, p.319
Be made aware of the conservation efforts being made in the area of wood energy.	G. Conservation 1. Insulation 2. Better heat exchange 3. Better regulation of heat 4. Forest management	Obtain and compare efficiency ratings on various woodburning stoves. Collect and display the various types of insulation.	Secure a speaker from the Extension Service or Forestry Commission to deliver a talk on wood conservation. Assist students with display construction.	Book 21, p.79 PS 10, Nov 78, p.8 Book 24, p.229 PS 10, Mar 78, p.38 PS 10, June 77, p.34
Be knowledgeable of the various careers available in the wood energy field.	H. Careers 1. Semi-skilled a. lumber stacker b. logger 2. Skilled a. lumber grader b. crane operator 3. Technician a. plant superintendent b. electrician 4. Professional a. chemist b. horticulturist			Occupational Outlook Handbook
			Present film/filmstrip.	See Appendix "B" for listing
		Test - Wood Energy	Construct test.	

UNIT XIII: ELECTRICAL POWER 15 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will: Be able to recall major facts pertaining to the development of electrical power.	A. Development 1. Electrical power generation Feraday 2. Light bulb - 1879-Edison 3. First Central Electric Station - 1882 - NYC 4. Steam powered generators produce most electrical power 5. Micro circuitry 6. Micro chips	Collect pictures, models, and articles relating to the development of electrical power.	Lecture/demonstration	Book 20, p.77 Book 13, pp.58,359
Have explored futuristic uses of electrical power.	B. Future Trends and Uses 1. Make efficient usage 2. Sodium-sulphur battery cells 3. Aerospace 4. Transportation 5. Research	Construct an experimental sodium-sulphur battery cell. Design and construct a model solar powered vehicle using a solar cell and electrical motor.	Assist students with the construction of the experiment. Set specifications for vehicles and pass out components. Present film/filmstrip.	Book 20, p.102 Example-Pitsco, IASCO, Radio Shack, etc. See Appendix "8"
Be able to list and give examples of the advantages of electrical power.	C. Advantages 1. Clean 2. Unlimited usage 3. Easy to transmit 4. Speed of transmission	Construct small motor generator demonstration unit.	Gather and pass out supplies and components and supervise construction.	Book 12b, p.74 (plans) Book 12, p.162
Be able to discuss the various disadvantages of electrical power.	D. Disadvantages 1. Cornea build-up 2. Potentially dangerous 3. Voltage drop (over a distance) 4. Storage not efficient 5. Production cost 6. Power failure	Discuss the effects of a long term power failure in a local community.	Lecture/demonstration Lead discussion.	

UNIT XIII: ELECTRICAL POWER (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Have become familiar with the terminology related to electrical power.	E. Vocabulary	Define the following vocabulary terms: current, Ohm's Law, direct current, alternating current, magnetic field, resistance, generator, relay, circuit breaker, conductor, polarity.	Pass out vocabulary sheet.	See Glossary
		Complete word puzzle.	Construct word puzzle.	See Appendix "9"
		Test - Electrical Power	Construct test.	

UNIT XIV: MECHANICAL POWER 25 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will: Understand the basic advantages and development of simple machines.	A. Development 1. Muscle powered machines a. crank operated b. treadle operated c. treadmill d. bow	Build one or more models of early muscle powered machines.	Lecture/demonstration Provide instructions and materials for project.	Book 12, p.20 Book 12b, p.16 (plans) See Appendix "12" & "15", p 121
	2. Steam powered machines a. Fulton's steamboat - 1807 b. Kempelen and Trevithick Steam Turbine - 1815 c. Cooper's Steam Locomotive - 1830	Construct a simple steam turbine.	Provide plans and materials for the construction of a steam turbine.	Book 20, p.56 Book 13, pp.11,43 Book 20b, p.47 (plans)
Have explored several uses of mechanical power.	3. Internal combustion powered machines a. Daimler's gasoline engine - 1885 b. Duryea's Automobile-1893 c. Wright Bros. heavier than air flight -1907	Collect and display models of various internal combustion powered machines.	Obtain service managers or other similar personnel to speak on the subject of internal combustion engines.	Book 20, p.110 Book 13, p.148
	4. Rocket development-1920's	Design, construct and race "Metric 500" car.	Obtain parts, hand out instructions and supervise construction.	Pitsco Catalog See Appendix "15",p 110
	5. Jet propulsion - 1940's	Build and test model of a pulse jet engine.	Collect materials and assist with the construction and testing.	
Have been exposed to futuristic uses of mechanical power.	B. Future Trends 1. Robotics 2. Aerospace 3. Transportation	Write a short paper predicting and defending a future use of mechanical power.	Promote a classroom discussion on selected student predictions.	Heathkit, Rhino, Lenox (Robots) Book 20, p.164

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UNIT XIV: MECHANICAL POWER (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Be able to list and give examples of the advantages of mechanical power.	C. Advantages 1. Durability 2. Multiplies force 3. Precision 4. Adaptability 5. Energy/cost efficiency	Using an erector set, design and fabricate a device that will show how mechanical power multiplies force.	Obtain erector set or similar kit for student experiments.	Hobby Shop, Toy Store, etc.
Be able to discuss the various disadvantages of mechanical power.	D. Disadvantages 1. Bulky equipment 2. Complex construction 3. Oxydization	Experiment with the oxydization process on steel, aluminum and copper.	Obtain the three metals and necessary materials to conduct the experiment.	
Have become familiar with the terminology related to mechanical power.	E. Vocabulary	Define the following vocabulary terms: horsepower, torque, friction, inertia, reciprocating, linear, ignition, clutch, cam, tension, seal, follower, input/output, tappet.		See Glossary
		Complete word puzzle.	Construct word puzzle.	See Appendix "9"
			Show film/filmstrip.	See Appendix "8"
		Test - Mechanical Energy	Construct test.	

UNIT XV: FLUID POWER 20 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the student will: Understand the basic advantages and development of fluid power.	A. Development 1. Irrigation-Egypt 2. Plumbing system - Crete 3. Science of Hydraulics-Pascal - 1600's 4. Workable Hydraulic Press-1795 5. Hydraulic Accumulator - 1850 6. Variable stroke pump-1875	Collect pictures, articles, and scale models of fluid power systems for a classroom display	Lecture/discussion Prepare bulletin board and display area for the students' collection.	Book 15,pp.472,473 Book 20, p.221 Book 12, pp.219,223
Be made aware of the current uses of fluid power.	B. Today's Uses 1. Brake systems 2. Lifting devices 3. Power tools 4. Heavy equipment 5. Transportation	Construct a hydraulic brake system module. Prepare a cutaway of a hydraulic jack. Clean, section, and print various components of an automatic transmission.	Assist students with brake system module and hydraulic jack cutaway projects. Obtain automatic transmission from junk yard and guide students with their project.	Book 13, p.473 Book 20, p.41 Book 12, p.216 Book 12, pp.224, 227
Have been exposed to futuristic uses of fluid power.	C. Future Uses 1. Robotics 2. Aerospace 3. Manufacturing		Have a representative from a local industry discuss the various ways hydraulics and pneumatics are being used by industry.	Book 12 pp. 215, 216, 227 Book 13, p.489
Be able to list and give examples of the advantage of fluid power.	D. Advantages 1. Easy power transmission 2. No lubrication 3. Smooth constant motion 4. Accurate control	List five advantages of fluid power systems over mechanical transactional systems.		Book 13, p.476 Book 12, pp. 217, 221 Book 20, p.221 Book 15,pp. 246, 248

UNIT XV. FLUID POWER (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Be able to discuss the various disadvantages of fluid power.	E. Disadvantages 1. Rust and corrosion 2. Water separation 3. Foam formation			Book 13, p.45
			Present film "Mechanics of Fluids: Fundamental Principles of Flow."	See Appendix "8"
Have become familiar with the terminology relative to fluid power.	F. Vocabulary	Define the following vocabulary terms: relief valve, pneumatic, hydraulic, actuator, regulator, vacuum, pressure, viscosity, static pressure, compression, reservoir.		See Glossary
		Complete word puzzle.	Construct word puzzle.	
		Compile ten questions with correct answers relating to fluid power.	Conduct quiz bowl using students' questions.	
		Test - Fluid Power	Construct Test.	

APPENDIX 1

ABBREVIATIONS

ABBREVIATIONS

MPH	Miles Per Hour
HP	Horsepower
PSI	Per Square Inch
BTU	British Thermal Unit
R	Resistance
Cu. Ft.	Cubic Foot
Gal.	Gallon
Bl.	Barrel
Oz.	Ounce
Gm.	Gram
Mg	Milligram
E	Voltage
I	Amperage
Pcs.	Pieces

APPENDIX 2

DEFINITIONS

DEFINITIONS

Renkin - Unit of measure for radiation

Mass - Quantity of matter

Ounces - 1/16 of a pound

Gram - unit of weight - 1/1000 kilogram

Milligram - unit of weight - 1/1000 gram

Calories - The heat to raise temperature of 1 cc of water $1^{o}C$

Board foot - Unit of measure for wood - $\frac{\text{\# Pcs x L" x W" x T"}}{144"}$

Cord - Cubic measure of wood 4' x 4' x 8'

Rick - 1/2 cord - 2' x 4' x 8'

Mega - One million times

APPENDIX 3

FORMULAS

FORMULAS

Displacement - Area of bore x length of stroke

Area of Bore - Diameter of bore x diameter of bore x .7854

Work - Force x Distance

Force - Mass x Acceleration

Kinetic Energy - $1/2 (\text{mass} \times \text{volume})^2$

Potential Energy - Mass x Gravity x Height

Power - Work ÷ Time

Work = Energy = Power x Time

Horsepower = Work ÷ Time (in min.) x 33,000

Horsepower - Work ÷ Time (in sec.) x 550

Efficiency - Output work ÷ Input work

Ohm's Law - Voltage = Amperage x Resistance

Wattage = Amperage x Voltage

Resistance = Voltage ÷ Amperage

Brake Horsepower - Force (in ounces) x RPM ÷ 100,000

Horsepower = Watts ÷ 746

Board Feet = $\frac{\text{Length} \times \text{Width} \times \text{Thickness}}{144}$

Circumference = πD 3.1416 x Diameter

APPENDIX 4

SHOP SAFETY

SHOP SAFETY

No Horseplay

Keep Shop Clean

Protect Eyes At All Times

Use Extreme Caution With Compressed Air

Do Not Carry Sharp Tools In Your Pocket

Know Location of Fire Extinguishers

Do Not Use Tools Until You Have Been Checked Out With Them

Obtain Help When Moving Heavy Objects

Avoid Skin Contact With Chemicals

Protect Your Hearing

Dress Properly

Handle Gasoline With Extreme Care

Report All Injuries To Instructor

Use Care When Handling Hot Objects

Do Not Leave A Running Machine Unattended

Notify Instructor Of Any Breakage

Use Tools Only For Purpose Intended

A-B-C - Always Be Careful

Think Before Acting

APPENDIX 5

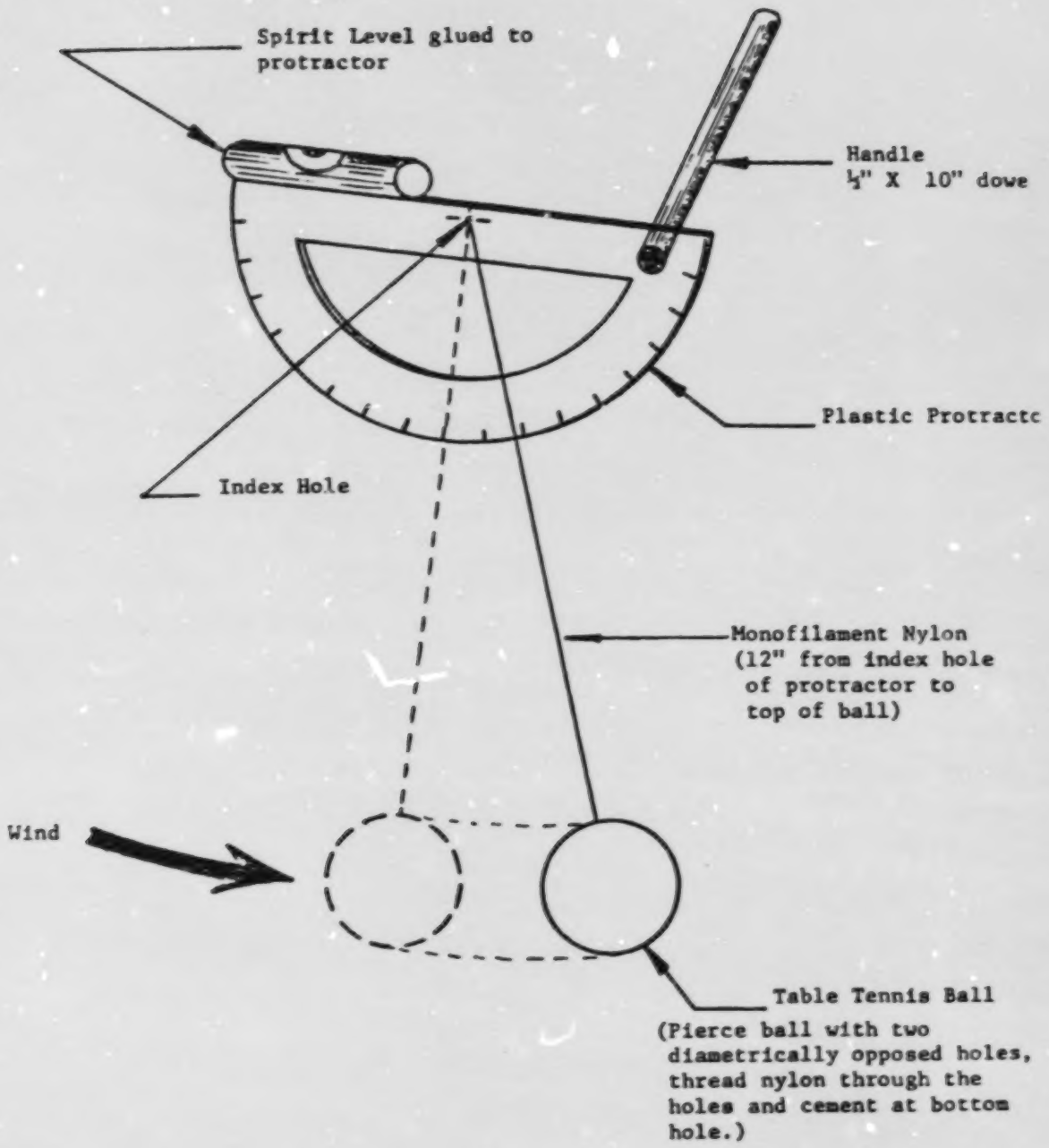
PULLEY DATA TABLE

PULLEY DATA TABLE

FIXED	MOVABLE	COMBINATION	
			NUMBER OF ROPES HOLDING UP LOAD
			POUNDS FORCE REQUIRED TO LIFT THE LOAD
			MECHANICAL ADVANTAGE (RATIO)
			DISTANCE ROPE WAS PULLED TO LIFT LOAD ONE FOOT (MEASURE WITH A RULE)

APPENDIX 6

WIND VELOCITY METER AND RECORD OF WIND SPEED MEASUREMENT


Spirit Level glued to protractor
Handle
½" X 10" dowe
Plastic Protracto
Index Hole
Monofilament Nylon
(12" from index hole of protractor to top of ball)
Wind
Table Tennis Ball
(Pierce ball with two diametrically opposed holes, thread nylon through the holes and cement at bottom hole.)

WIND VELOCITY METER
(Anemometer)

Record of Wind Speed Measurement

Measurements taken and recorded by: _____

Address where measurements taken: _____

Date	Time of Day	Protractor Angle	Wind Speed (mph)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			

Angle	Miles Per Hour
90	0
85	5.80
80	8.23
75	10.1
70	11.8
65	13.4
60	14.9
55	16.4
50	18.0
45	19.6
40	21.4
35	23.4
30	25.8
25	28.7
20	32.5

To find the average wind speed add all of the wind speed measurements and divide this total by the total number of observations made. Example: If the total of all wind speed measurements was 330, and this was the result of 30 observations during the month, the average wind speed for that month would be: $\frac{330}{30}$ = 11 mph. What is the average wind speed for your area? _____

APPENDIX 7

"SHOULD YOU SHOWER OR TAKE A TUB BATH?"

"Should You Shower or Take a Tub Bath?"

Here's a surprising fact: If people who took tub baths took showers instead, we'd save a lot of energy. This experiment demonstrates what we mean.

Start by taking a bath. Fill your bathtub with water adjusted to the temperature you like best, but before you step in, use your yardstick to measure the depth of water in the tub.

Next, take shower (better wait till you really need one!). Before you begin, though, do something unusual: close the bathtub drain so that the shower water will collect in the tub. When you are finished (take your time), measure the depth of water that has collected. Compare this reading with the bath water depth.

You will find that your shower used substantially less water . . . . probably less than half as much!

APPENDIX 8

FILMS AND FILM STRIPS

FILMS AND FILM STRIPS

CODE	SOURCE
ERDA	ERDA Film Library Technical Information Center P. O. Box 62 Oak Ridge, Tennessee 37830
NGS	National Geographical Society Department 1037 Washington, D.C. 20036
AEA	Grant Wood AEA Film Library 4401 Sixth Street Southwest Cedar Rapids, Iowa 52401
TP & L	Texas Power and Light, Public Service Department P. O. Box 226331 Dallas, Texas 75266
MTP	Modern Talking Pictures 1212 Avenue of the Americas New York, NY 10036
JWN	J. Weston Walch Publisher Portland, Maine 04104
LSU	Instructional Resources Center Louisiana State University Baton Rouge, Louisiana 70803
IU	University of Illinois Visual Aids Service 1325 South Oak Street Champaign, IL 61820
MOU	University of Missouri Academic Support Center 505 E. Stewart Road Columbia, MO 65211
KU	University of Kansas Audio Visual Center 746 Massachusetts Street Lawrence, KS 66044

Films and Film Strips (Continued)

CODE	SOURCE
COU	University of Colorado Educational-Media Center 348 Stadium Building Boulder, CO 80302

NOTE. Write each supplier for a catalog. Detailed information for each film will be given in the catalog.

UNIT I: POWER/ENERGY

"Energy: Critical Choices Ahead" (27 min. color) Free loan - TPL

"Energy: The American Experience" (28 min. color) #0507 - Free Loan-ERDA

"Challenge of the Future" (29 min.) #0508 - Free Loan - ERDA

"This World of Energy" (Color) Cost - NGS

"A Question of Balance" (28 min. color) - Free Loan - MTP

"The Leading Edge" #4411 - Free Loan - MTP

"Our Energy Problems" (22 slides color) - JWW

"Energy and Work" (10 Color) Rental - LSU

"Energy: New Sources" (20 min. color) - IU

"Energy: The Dilemma" (21 min. color) IU, CU

UNIT II: MECHANICAL ADVANTAGES

"Machine" (10 min. color)- Rental - COU

"Machine" (30 min. B & W) Rental - MOU

"Machine" (10 min. B & W) Rental - KU, COU

"Machines Help Us" (11 min. B & W) Rental - COU

"Machines Do Work" (11 min. B & W) Rental - COU

UNIT III: WIND

"What Makes the Wind Blow" - AEA

"Wind and What It Does" (11 min. color) Rental - LSU

"Air and What It Does" (11 min. color) Rental - LSU

UNIT IV: WATER

"Waves on Water" (15 min. color) Rental - LSU

"Water: (14 min. color) Rental - IU

"Water Power" (11 min. B & W) Rental - IU, MOU

UNIT V: SOLAR

"Your Place in the Nuclear Age" (26 min. color) #0452 - ERDA

"To Imitate the Sun" (33 min. color) #0474 - ERDA

"To Bottle the Sun" (5½ min. color) #0488 - ERDA

"Here Comes the Sun" (15 min. color) #0499 - ERDA

"Putting the Sun to Work" (5 min. color) #0502 - ERDA

"Solar Energy: To Capture the Power of Sun and Tide" (22 min. color) Rental LSU, KU, IU

UNIT VI: GEOTHERMAL

"Geothermal Power" (14 min. color) Rental - CU, IU

UNIT VII: ELECTRICAL

"Electricity All About Us" (21 min.) #00189 Rental - AEA, IU, COU, KU

"Electricity: The Way It Works" (16 min. color) Rental - MOU

UNIT VII: FOSSIL FUEL

"Fuels, Their Nature and Use" (11 min. color) Rental - COU, IU, MOU

UNIT IX: NUCLEAR

"Controlling Atomic Energy" (13 min.)

"Nuclear Power and the Environment" (14 min. color) #0447 - ERDA

"The Fuel of the Future" (29 min. B & W) #0141 - ERDA

"On the Move" (28 min. color) #0496 - ERDA

"Nuclear Power and Space" (12 min. color) #0226 - ERDA

"Horizons Unlimited" (37 min. color) #450 - ERDA

"Atomic Power Today" (15 min. color) #0410 - ERDA

"The Fifth Fuel" (22 min. color) #409 - ERDA

"Energy: The Nuclear Alternative" (20 min. color) Rental - LSU

UNIT X: CHEMICAL

"Electricity from Chemicals" (14 min. color) Rental - IU

UNIT XI: BIO-CONVERSION

"The Garbage Explosion - Saving the Environment" (15 min. B & W) Rental - MOU, COU, IU

UNIT XII: WOOD

"Problems of Conservation: Our Natural Resources" - AEA

"The Changing Balance of Nature" - AEA

"Energy to Burn" - AEA

UNIT XIII: ELECTRICAL POWER

"Power" (19 min. color) Rental - IU

UNIT XIV: MECHANICAL POWER

"Power for Progress" (17 min. color) Rental - COU

"Power Train" (13 min. color) Rental - IU

UNIT XV: FLUID POWER

"Mechanics of Fluids: Fundamental Principles of Flow" (23 min. color)

"Fluid Flow in Hydraulic Systems" (10 min. color) Rental - IU

"Fluids in Motion" (30 min. B & W) Rental - IU

APPENDIX 9

SAMPLE OF WORD PUZZLE

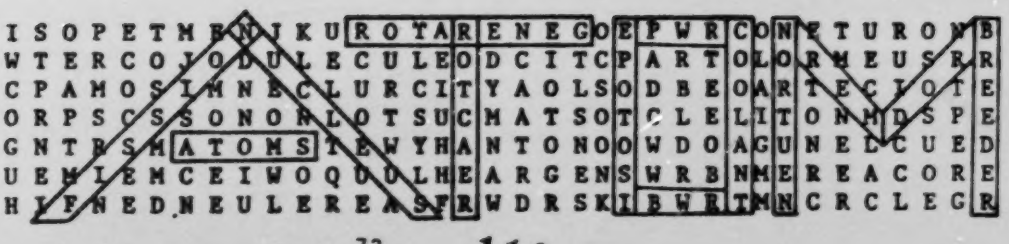
Nuclear Word Puzzle

A list of words related to nuclear energy is given below the puzzle. Look for the words hidden in the puzzle. When you find one, circle it and mark it off the list until you have found all the words.

```
I S O P E T M E N J K U R O T A R E N E G O E P W R C O N E T U R O N B
W T E R C O J O D U L E C U L E O D C I T C P A R T O L O R M E U S R R
C P A M O S I M N E C L U R C I T Y A O L S O D B E O A R T E C I O T E
O R P S C S S O N O N L O T S U C M A T S O T C L E L I T O N M D S P E
G N T R S M A T O M S T E W Y H A N T O N O O W D O A G U N E L C U E D
U E M I E M C E I W O Q U U L H E A R G E N S W R B N M E R E A C O R E
H I F N E D N E U L E R E A S F R W D R S K I B W R T M N C R C L E G R
```

breeder
fission
atoms
nucleus
generator
reactor
isotope
PWR
BWR
coolant
neutron
REM
rod

Answers


I S O P E T M E N J K U R O T A R E N E G O E P W R C O N E T U R O N B
W T E R C O J O D U L E C U L E O D C I T C P A R T O L O R M E U S R R
C P A M O S I M N E C L U R C I T Y A O L S O D B E O A R T E C I O T E
O R P S C S S O N O N L O T S U C M A T S O T C L E L I T O N M D S P E
G N T R S M A T O M S T E W Y H A N T O N O O W D O A G U N E L C U E D
U E M I E M C E I W O Q U U L H E A R G E N S W R B N M E R E A C O R E
H I F N E D N E U L E R E A S F R W D R S K I B W R T M N C R C L E G R

APPENDIX 10

INFORMATIONAL SOURCES

INFORMATIONAL SOURCES

The following list of companies, institutions, universities and government agencies are sources for obtaining information associated with Power/Energy.

Central Power and Light Company
P. O. Box 2121
Corpus Christi, Texas 78403

Consumers Power Company
212 W. Michigan Avenue
Jackson, Michigan 49201

Edison Foundation
Southfield, Michigan 48037

Electrical Industries Association
Los Angeles, California 90052

Energy Conservation Resources for Education
Department of Industrial Education
Texas A & M University
College Station, Texas 77841

Federal Energy Administration
Washington, D.C. 20461

Federal Power Commission
Washington D.C. 20461

Houston Lighting and Power Marketing
Research Department
Houston, Texas 77201

Lone Star Gas Company
301 South Harwood Street
Dallas, Texas 75201

Lawrence Berkeley Laboratory
Energy Environment Division
University of California
Los Angeles, California 90052

Mobil Oil Corporation
150 E. 42nd Street
New York, NY 10017

National Geographic Society
Dept. 1037
Washington, D. C. 20036

BEST COPY AVAILABLE

Informational Sources (Continued)

National Science Teachers Association
1742 Connecticut Avenue
Washington, D. C. 20461

Office of Public Affairs
Washington, D. C. 20545

Pacific Gas and Electric Company
San Francisco, California 94188

Shell Oil Company
Houston, Texas 77021

The Institute for Energy Research
Texas Tech University
Lubbock, Texas 79409

USAEC Technical Information Center
Oak Ridge, Tennessee 37830

U. S. Department of Energy
Washington, D. C. 20585

U. S. Energy Research and Development Administration
Washington, D. C. 20545

U. S. Environmental Protection Agency
Washington, D. C. 20460

U. S. Government Printing Office
Superintendent of Documents
Washington, D. C. 20461

APPENDIX 11

MODEL ROCKET TEST DATA CHART

MODEL ROCKET

TEST DATA CHART

PAYLOAD	MEASURED ALTITUDE	FLIGHT TIME TO PEAK	MEASURED COAST TIME*
NONE			
1 OUNCE			
2 OUNCE			

*Subtract engine thrust time from the flight time to peak to obtain the measured coast time.

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APPENDIX 12

DIRECTORY OF SUPPLIERS

DIRECTORY OF SUPPLIERS

Below are sources one can contact to obtain information on projects and materials supplies.

Centuri Flying Model Rockets
P. O. Box 1988
Phoenix, Arizona 85001

Hydraulics

Occupational Curriculum Laboratory
East Texas State University
Commerce, Texas 75425
Telephone - 214/886-5623

Mechanical Power

Simple Working Models of Historic Machines by Aubrey E. Burstall

M.I.T. Press
50 Ames Street
Cambridge, Massachusetts 02142

Model Rocketry

Estes Industries
P. O. Box 227
Penrose, Colorado 81240

APPENDIX 13

SAMPLE TEST QUESTIONS

MEASURING ACHIEVEMENT

The following are sample or suggested test questions for each unit of study. The following test questions are by no means complete nor exhaustive. They are merely a representation of some of the better material available. Also included are suggestions for directions for examinations.

General Directions

This test consists of five parts: true and false, matching, multiple choice, completion, and listing. There will be 50 minutes alloted for the test. If there are questions please ask them before the class starts the test. If there are urgent questions while taking the test, raise your hand. Upon completion of the test, turn your paper over and remain quietly in your seat. Begin.

True and False Test:

Read the complete statement. If the statement is true, circle the T; if the statement if false, circle the F.

Matching:

In the blank at the left of the item number, record the letter of the description in the right column which identifies the item.

Multiple Choice:

In the blank at the left of the item number, record the letter of the answer that makes the statement correct.

Completion:

Fill in each blank with a word or words that complete(s) the statement correctly.

Listing:

In the spaces provided list concisely the information called for in each question.

Sample Test Layout

Date_____

Name_____

Period_____

Seat Number_____

Test Number_____

Score_____ Letter Grade_____

UNIT I: INTRODUCTION TO ENERGY

Sample Test

1. Name two forms of energy.

   1. _____
   2. _____

2. One exhaustible form of energy is electrical. True or False

3. _____fuel energy comes from dead vegetation.

4. Which of the following is not a form of power.

   A. Electrical
   B. Bio-conversion
   C. Mechanical
   D. Fluid

Answers

1. Potential
   Kinetic

2. F

3 Fossil

4. B

UNIT II: MECHANICAL ADVANTAGES

Sample Test

1. A lever is a form of incline plane. True or False

2. An example of a first-class lever would be

   A. human
   B. wheelbarrow
   C. crowbar
   D. pliers

3. A doorknob is an example of a _____ type of simple machine.

4. List the three functions of a screw.

   1.
   2.
   3.

Answers

1. F

2. C

3. Wheel axle

4. 1. Tighten
   2. Adjust
   3. Transmit power

UNIT III: WIND ENERGY

Sample Test

1. Sailing is the earliest known use of wind power. True or False

2. Two present uses of wind energy are

   1.
   2.

3. The _____ is used to measure wind speed.

4. Wind mills are not used to:

   A. pump water
   B. operate machinery
   C. produce solar energy
   D. generate electricity

Answers

1. T

2. 1. pump water
   2. generate electricity

3. Anemometer

4. C

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UNIT IV: WATER ENERGY

Sample Test

1. Two types of water wheels are:

   1.
   2.

2. P.S.I. stands for per square inch. True or False

3. The chemical symbol for water is _____.

4. Which of the following is not an environmental effect of water energy?

   A. Heat discharge
   B. Erosion
   C. Flooding
   D. Irrigation

Answers

1. 1. undershot
   2. overshot

2. T

3. H_2O

4. D

UNIT V: SOLAR ENERGY

Sample Test

1. Heat pumps were in use as early as the 1600's. True or False

2. Electrical energy is measured in _____ hours.

3. Which of the following is not a present use of solar energy?

   A. Heating water
   B. Producing electricity
   C. Desalinization
   D. Pumping water

4. What is a solar application of water?

Answers

1. T

2. Kilowatt

3. D

4. To store heat for the heating of homes, schools, businesses, etc.

UNIT VI: GEOTHERMAL ENERGY

Sample Test

1. Geothermal energy is usually observed in the form of _____.

2. List three countries where geothermal energy is being used.

   1.
   2.
   3.

3. Magma is a waste product of geothermal. True or False.

4. Which is not a by-product of geothermal energy?

   A. Silicon
   B. Steam
   C. Heat
   D. Geyser

Answers

1. steam

2. 1. Iceland
   2. Italy
   3. Japan

3. F

4. A

UNIT VII: ELECTRICAL ENERGY

Sample Test

1. Lightning is a source of electrical energy. True or False

2. List two types of electrical current.

   1.
   2.

3. A _____ is a storage unit for electrical energy.

4. Which of the following is not an electrical component?

   A. Capacitor
   B. Rectifier
   C. Static
   D. Transformer

Answers

1. T

2. 1. A.C.
   2. D.C.

3. Battery

4. C

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UNIT VIII: FOSSIL FUEL ENERGY

Sample Test

1. List three types of fossil fuels.

   1.
   2.
   3.

2. Acid rain is a form of pollution from coal. True or False

3. Anthracite and bituminous are two types of _____.

4. The majority of today's electrical power is produced by steam fired by:

   A. wood
   B. oil
   C. gas
   D. coal

Answers

1. 1. coal
   2. petroleum
   3. gas

2. T

3. coal

4. D

UNIT IX: NUCLEAR ENERGY

Sample Test

1. A Renkin is a measurement of nuclear energy. True or False

2. The formula $E = MC^2$ was developed by _____.

3. List three uses of nuclear energy.

   1.
   2.
   3.

4. Which is not a source of nuclear fuel?

   A. Isotope
   B. Uranium
   C. Plutonium
   D. Thorium

Answers

1. F.

2. Einstein

3. 1. electrical power
   2. weapons
   3. medical

4. A

UNIT X: CHEMICAL ENERGY

1. Chemical energy is a synthetic fuel energy. True or False

2. Chemical energy was used by the Chinese to propel early forms of _____.

3. What two measurements were necessary to compute the altitude of a rocket using the rocket tracing device?

   1.
   2.

4. Of the following which is not a use of chemical energy?

   A. Transportation
   B. Agriculture
   C. Heating
   D. Explosives

Answers

1. T

2. rockets

3. 1. distance from launch site
   2. angle to apogee

4. B

UNIT XI: BIO-CONVERSION ENERGY

Sample Test

1. Bio-conversion is a method for creating coal. True or False.

2. Alcohol is derived through a process called _____.

3. List two main uses of bio-conversion.

   1.
   2.

Answers

1. F

2. Fermentation

3. Reducing solid waste
   Creating fuel

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UNIT XII: WOOD ENERGY

Sample Test

1. Wood is the first form of energy used by man. True or False.

2. To make better use of wood energy you should have:

   A. good insulation
   B. better heat exchange
   C. better regulation of heat
   D. photosynthesis

3. Pitch, turpentine, and resin are known as _____.

4. List three present day uses of wood energy.

   1.
   2.
   3.

Answers

1. F

2. D

3. Naval stores

4. 1. heat
   2. light
   3. charcoal

UNIT XIII: ELECTRICAL POWER

Sample Test

1. The first light bulb was invented by _____.

2. Steam power generators produce most of our electrical power.
   True or False

3. List four advantages of electrical power.

   1.
   2.
   3.
   4.

4. Which of the following is <u>not</u> a disadvantage?

   A. Cornea build-up
   B. Production cost
   C. Power failure
   D. Micro-circuitry

<u>Answers</u>

1. Edison

2. T

3. 1. clean
   2. unlimited usage
   3. easy to transmit
   4. speed of transmission

4. C

UNIT XIV: MECHANICAL POWER

Sample Test

1. The first mechanical devices were powered by steam. True or False

2. The first steam boat was invented by:

   A. James Watt
   B. Tom Eppler
   C. Robert Fulton
   D. Louis Cooper

3. List two muscle power machines.

   1.
   2.

4. Bulky equipment, complex construction, and oxidization are _____ of mechanical power.

Answers

1. F

2. B

3. 1. treadle lathe
   2. treadmill

4. Disadvantages

UNIT XV: FLUID POWER

Sample Test

1. List the two basic types of fluid power.

   1.
   2.

2. The primary use of fluid power in my automobile is in the _____ system.

3. Archimedes discovered the science of hydraulics. True or False

4. Which of the following do not represent some use of fluid power?

   A. Power tools
   B. Rocket development
   C. Transportation
   D. Heavy Equipment

Answers

1. Hydraulic
   Pneumatic

2. Brake

3. F

4. B

APPENDIX 14

RESOURCE MATERIALS

RESOURCE MATERIALS

The following list of resource materials are by no means complete or exhaustive. They merely represent some books from the Louisiana State adopted textbook list and other available materials used by metalworking teachers.

1. Pershing, Rex W. Energy and Power Model Rocket. Des Moines, Iowa: Department of Public Instruction, Career Education Division, 1979.

2. Walker, John R. Exploring Power Technology. South Holland, Illinois: Goodheart-Wilcox Co., 1981.

3. Pershing, Rex W. Energy and Power Alternate Energy. Des Moines, Iowa: Department of Public Instruction, Career Education Division, 1980.

4. Toffolon, John E. Power Technology. Hartford, Connecticut: Bureau of Vocational Services, 1981.

5. Webster, Jay. Small Engine Operation and Service. Chicago: American Technical Publishers, Inc., 1981.

6. Pershing, Rex W. Energy and Power. Des Moines, Iowa: Department of Public Instruction, Career Education Division, 1980.

7. Miller, Wilbur R. Basic Industrial Arts Electricity. Bloomington, Illinois: McKnight Publishing Co., 1978.

8. Barkhouse, Bob. Engine Repair. Bloomington, Illinois: McKnight Publishing Co., 1975.

9. Wetzel, Guy F. Automotive Diagnosis and Tune-Up. Bloomington, Illinois: McKnight and McKnight Publishing Co., 1974.

10. Glenn, Harold T. Auto Mechanics. Peoria, Illinois: Charles B. Bennett Co., Inc., 1976.

11. Crouse, William H. Automotive Mechanics. New York: McGraw-Hill Book Co., 1970.

12. Ellinger, Herbert E. Automechanics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972.

13. Duffy, Joseph W. Power Prime Mover of Technology. Bloomington, Illinois: McKnight & McKnight Publishing Co., 1972.

14. Drake, George R. The Repair and Maintenance of Small Gasoline Engines. Reston, Virginia: Reston Publishing Co., Inc., 1976.

15. Bohn, Ralph C. and MacDonald, Angus J. Power Mechanics of Energy Control, Bloomington, Illinois: McKnight Publishing Co., 1983.

16. Pershing, Rex. Energy and Power Model Rocket. Des Moines, Iowa: Department of Public Instruction, Career Education Division, 1980.

17. Purvis, Jud. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Co., Inc., 1963.

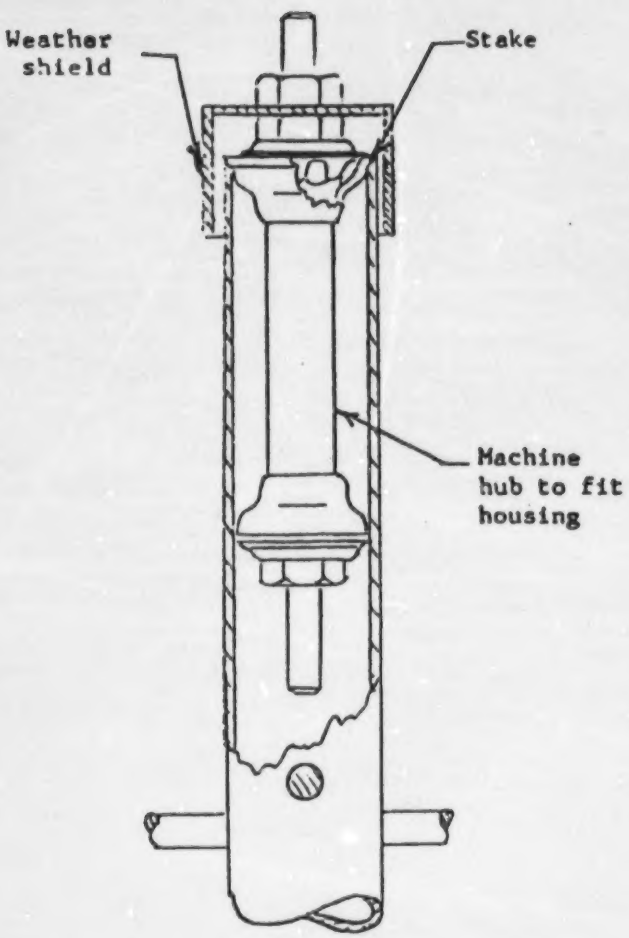
18. Stephenson, George E. Small Gasoline Engines. Albany, New York: Delmar Publishers, 1964.

19. Roth, Alfred C. Small Gas Engines. South Holland, Illinois: Goodheart-Wilcox Co., Inc., 1975.

APPENDIX 15

SAMPLE PROJECT/EXPERIMENT SHEETS

WEATHER VANE



Bearing design for weather vane

PULLEY FRAME CONSTRUCTION

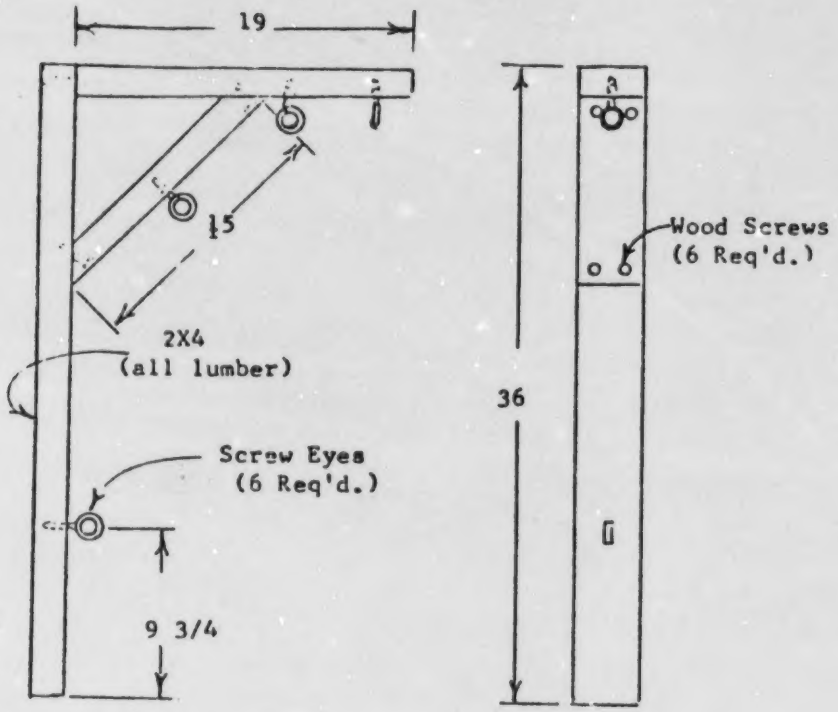


Figure 1 Basic Pulley frame construction.

Construct pulley frame as shown in Figure 1.

Set up the fixed pulley arrangement shown in Figure 2. Observe the number of pounds registered on the scale. Record the data.

Set up the movable pulley arrangement shown in Figure 3. Observe the number of pounds registered on the scale. Record the data.

QUESTIONS:

1. How many ropes are actually holding up the load?
2. How many pounds of force are required to lift the load?
3. How much mechanical advantage was gained?
4. How far was the rope pulled to lift the loads?

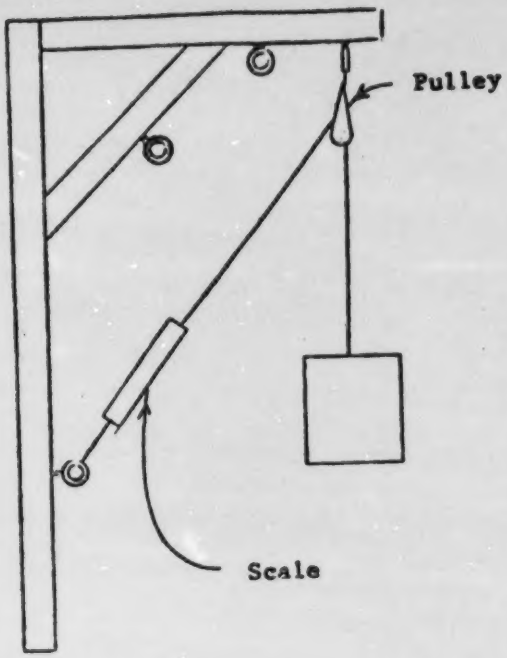


Figure 2. Fixed Pulley Arrangement.

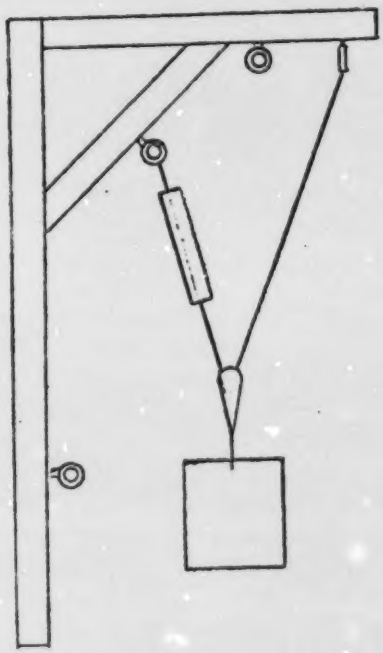
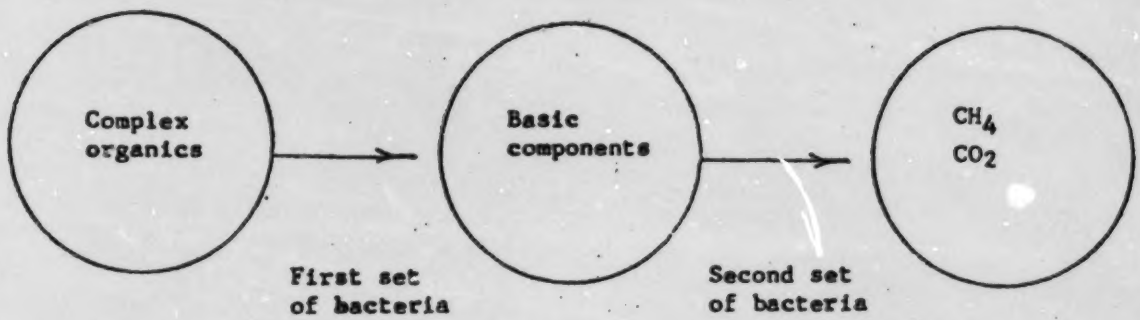


Figure 3. Movable Pulley Arrangement.

BIO-CONVERSION

Bio-gas is the result of specific micro-organisms decomposing organic matter in an anaerobic (meaning without oxygen) environment. The bacterial process for anaerobic decomposition is two-fold. First, one set of microbes breaks down the complex matter into its basic components. This is done in an oxygen environment. Secondly, as the oxygen is depleted, another set of microbes combine these basic components. (See Figure 1.)

Figure 1

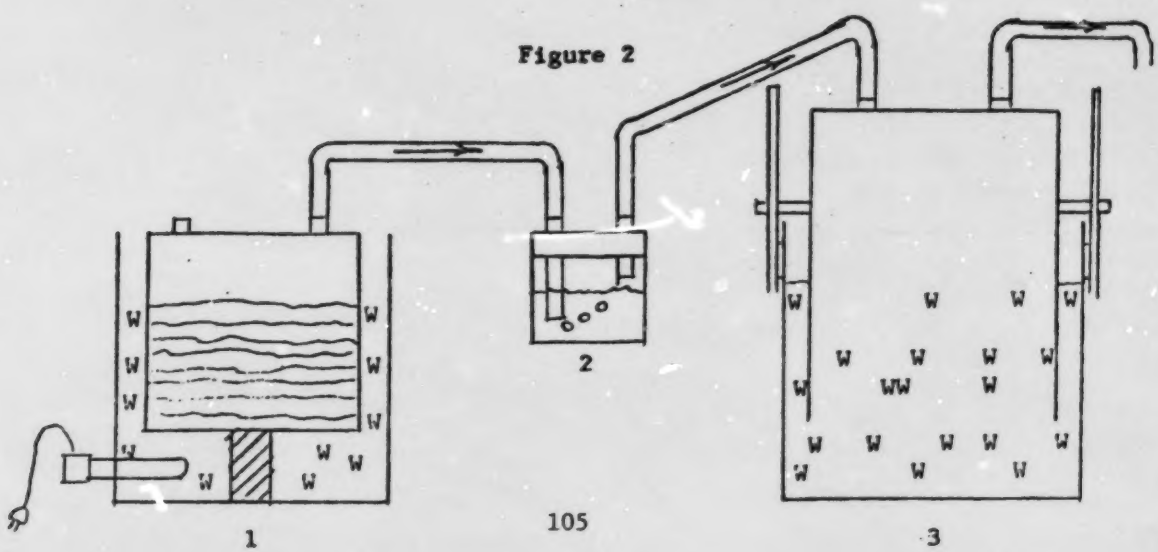


1. Use water from swamps, lakes or streams. (Tap water is relatively germ-free.)
2. Use urine whenever possible.
3. A major part of the slurry should consist of animal wastes.
4. To ensure a good supply of microbes, for the first batch use wastes from various areas.

MATERIALS AND CONSTRUCTION:

The following procedure and materials will provide your students with a working digester for use in a power and energy laboratory. (See Figure 2.)

Figure 2



MATERIALS FOR DIGESTER (No. 1):

1 5-gallon plastic bucket.
1 4-gallon tin can.
1 Aquarium heater
2 3/8" x 2" copper tubing.
Wood block and silicon sealer.

PROCEDURE:

Drill hole in plastic bucket, insert heater, seal with silicon rubber.
Seal seams in tin can, sweat solder two copper pipes into top.
Fill tin can 3/4 full with slurry.
Place top on tin and seal with silicon rubber.
Place wood block in plastic bucket.
Place tin into bucket on block.
Fasten tin into bucket.
Fill with water.
Turn on heater.

MATERIALS FOR GAS INDICATOR (No. 2):

1 40-oz. peanut butter jar and lid.
1 3/8" x 6" copper tubing.
1 3/8" x 2" copper tubing.

PROCEDURE:

Sweat solder copper pipes into lid 1" through top.
Screw top on securely.
Connect digester and gas indicator with 3/8" I.D. rubber hose.
Block off other outlet on digester by using hose and clamp.

MATERIALS FOR GAS COLLECTOR (No. 3):

1 5-gallon plastic bucket.
1 4-gallon tin.
2 3/8" x 2" copper tubing.
2 1/4" wood dowels.

PROCEDURE:

Invert 4-gallon tin (without lid) and sweat solder copper pipes in what is now the top.
Fasten wooden dowels to side of plastic bucket (parallel).
Place water in plastic bucket (nearly full).
Place inverted tin into bucket, allowing air to escape through pipes.
Connect gas indicator and collector with 3/8" I.D. rubber hose.
Block other outlet with rubber hose and clamp. (This will be the methane supply line.)

The unit should be airtight at this point. Any leaks in the digester will stop gas from forming. The design and construction of the methane plant does not follow rigid details because materials and sizes will vary. The simplicity and soft technology construction is a major advantage here.

In a week or so, the collector will start filling with gas. Precautions should be taken to eliminate all air from the lines by forcing the collector down and opening the clamp on the supply line. Repeat this procedure a few times over a period of two or three days as a safety precaution from the slight possibility of a small explosion.

UTILIZING THE GAS:

Methane should start forming within two to three weeks of initial construction, providing 20 to 30 cubic feet of gas over a two to three-month generating cycle.

Using the gas to cook is simple. An extremely efficient burner can be fabricated in the shop. (See Figure 3).

With the burner connected to your digester after the initial two to three weeks start-up time, you should be able to boil a pot of hot water for a nice cup of hot chocolate. Your students will see how something extremely useful can come from a rather unusual source of power. Further exploration, research, and experimentation in methane production and utilization is now possible for your students in Power and Energy.

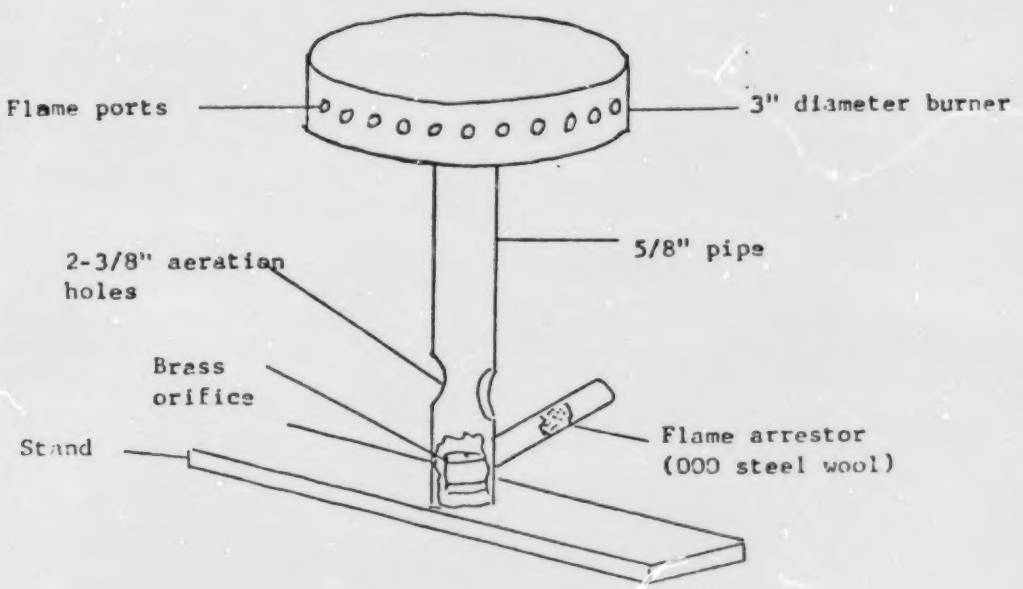
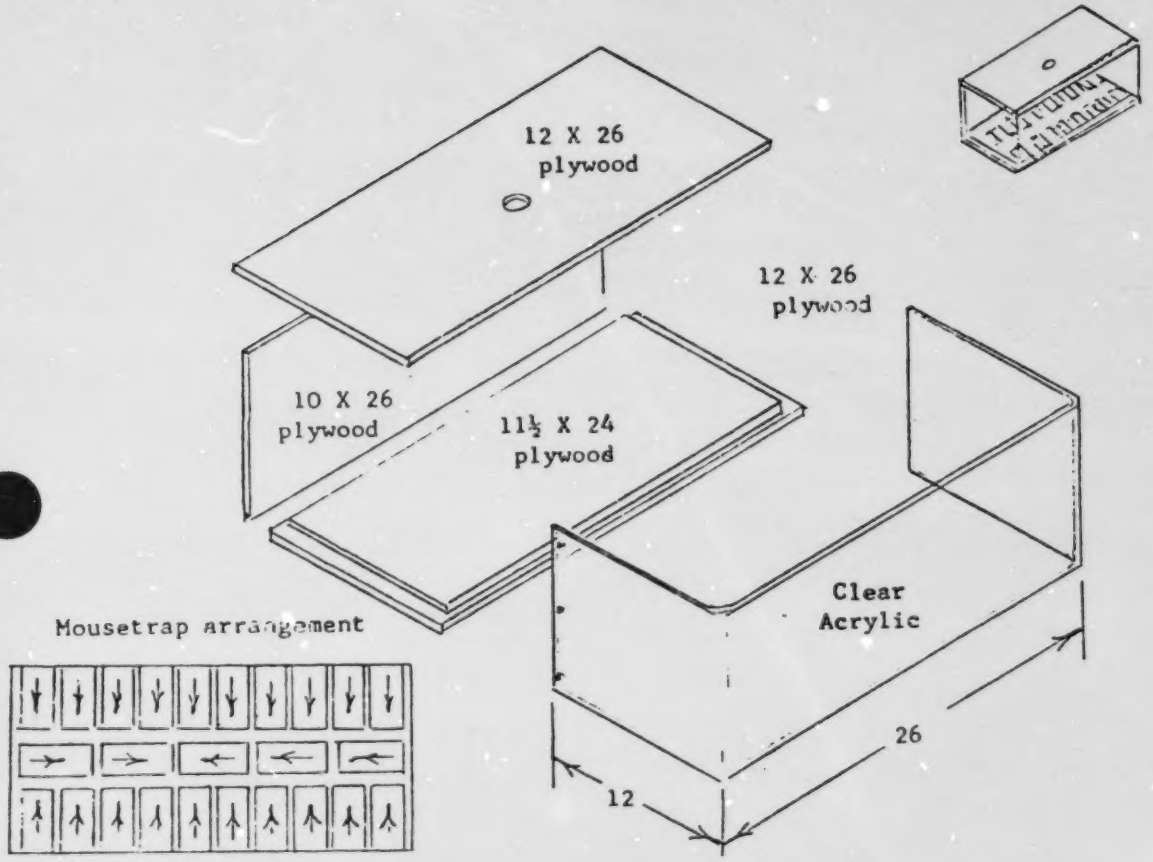


Figure 3

OPERATING PROCEDURES:

1. Set the mousetraps very carefully. The slightest bump or vibration will set them off.
2. Carefully place the ping-pong balls on each trap. Be sure you keep fingers clear of the triggers of the trap.
3. Place the acrylic box portion over the platform containing the traps. Do not jar the platform, since this may spring the traps.
4. Drop the golf ball thorugh the hole in the top. Observe the reaction.

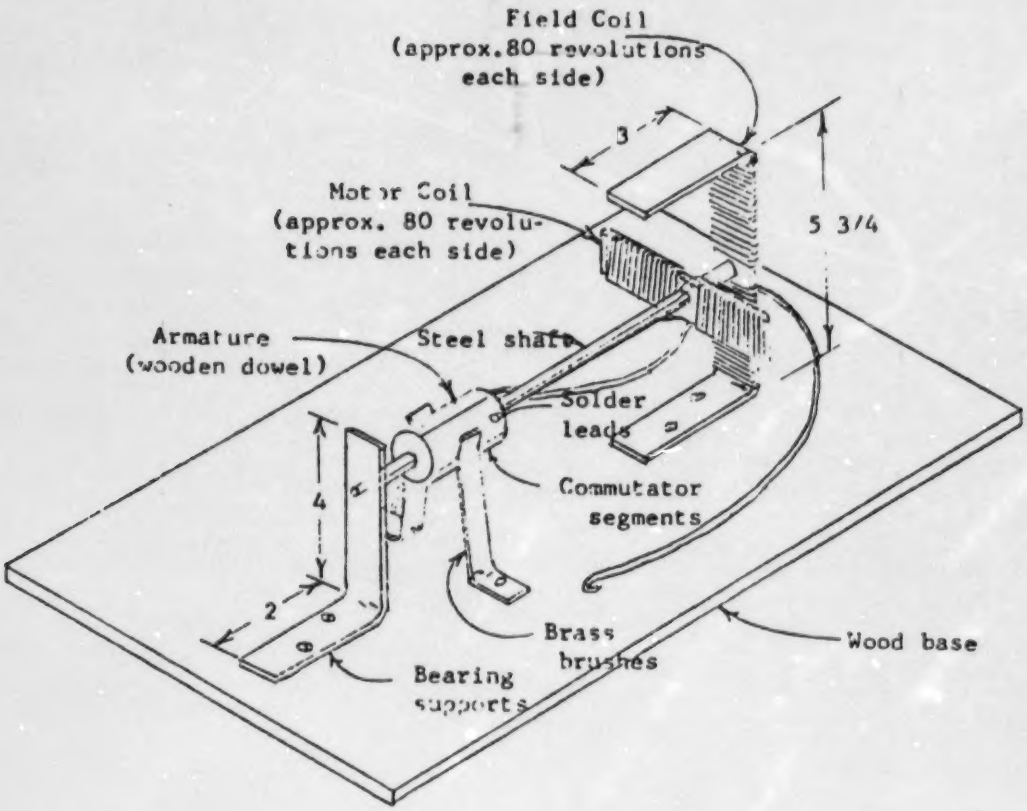
Figure 1. Exploded view of the nuclear fission demonstrator.



QUESTIONS:

1. What happened when the golf ball was dropped into the chamber?
2. How long would you estimate that it took to complete the reaction?
3. Was the experiment you performed a controlled chain reaction?
4. Describe the relationship between what you observed and nuclear fission.

SIMPLE ELECTRIC MOTOR



Components of the simple electric motor.

Bend the two longer pieces of band iron as shown in Figure above to form the bearing support and the field coil. Drill 5/32" holes in these two pieces to support the shaft. The holes should be 2 7/8" above the base when the motor is assembled. Also drill holes for mounting to the base.

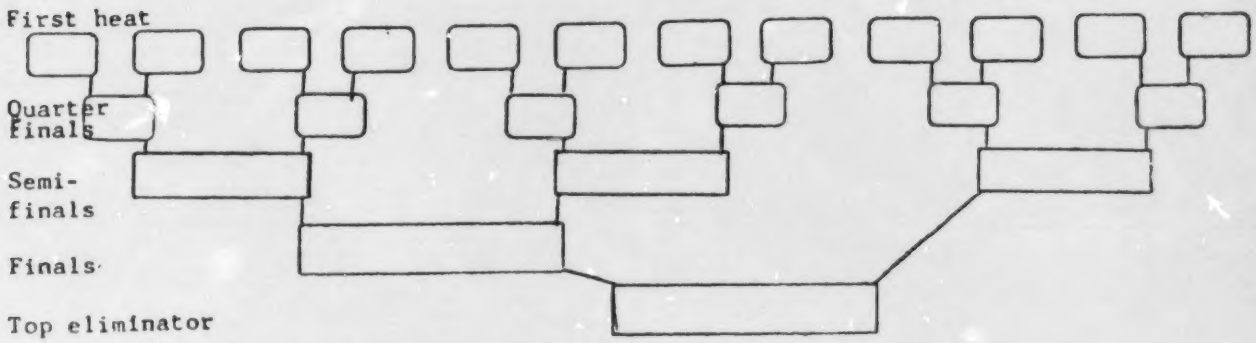
Drill a 3/8" hole in the center of the four-inch long piece of band iron, which will serve as the motor coil. Wind this coil as follows:

Leave about 12 inches of wire to serve as a lead, then begin winding about 1/2" from the center of the coil, working toward the end. Wind 40 turns of the wire, then begin working back toward the center. When you reach the starting point (which should total 80 turns), continue across to the other side of the coil. Do not cut the wire, since the coil must be continuous. Wind 40 turns outward from the center and 40 turns back. Leave a 12 inch lead, and cut off the remaining wire. To keep the coils from loosening, use a small amount of epoxy at the points where the leads come off the windings.

STUDENT JOBS FOR RUNNING THE METRIC 500

Job	No. of Students	Job Description
Car Hook-up	2	Places car on string
Starter	1	Operates firing device
Timer	2	Times run with stopwatch
Car Un-hook	2	Removes cars from string
Scale Tender	1	Weighs all cars
Weight Recorder	1	Records weight & assigns opponents
Chart Keeper	2	Records wins and forwards winners
Cartridge Dispenser	1	Issues cartridges to racers
Cartridge Remover	2	Removes cartridges after each race
Finish Flag	1	Re-sets flag after each race
Car Management	1	Forwards winners of heats to starting area for next elimination run.

METRIC 500 SAMPLE ELIMINATION CHART



LEVER SYSTEMS

Ra - resistance to force

Da - distance from fulcrum to applied force

Fb - applied force

Db - distance from resistance force to fulcrum

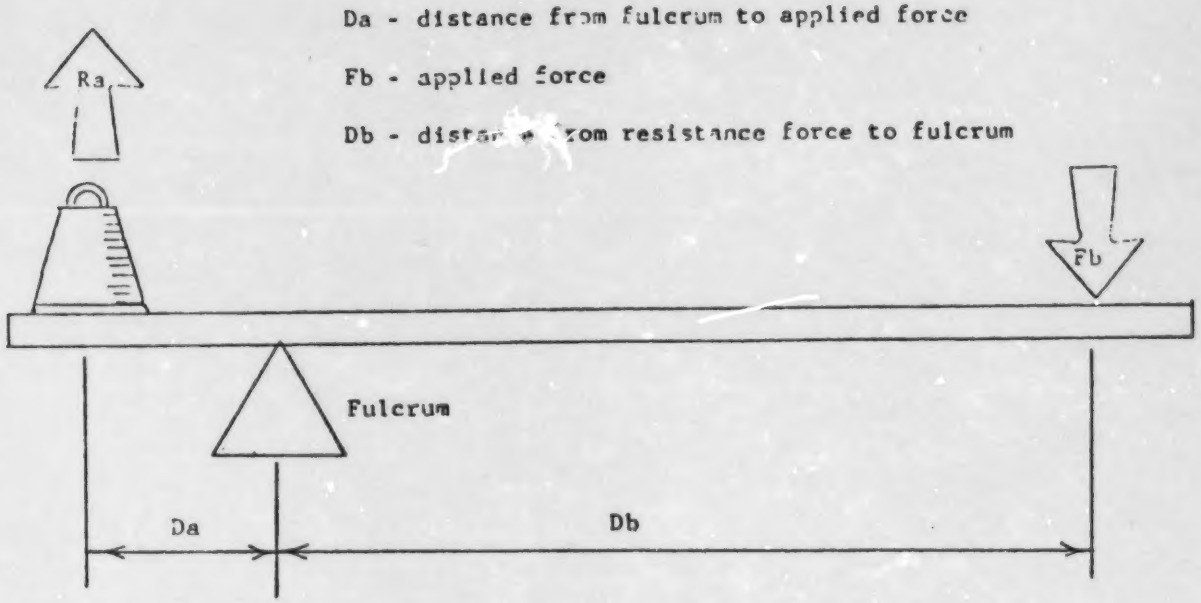


Figure 1 First-class lever: force, distance, and resistance relationships.

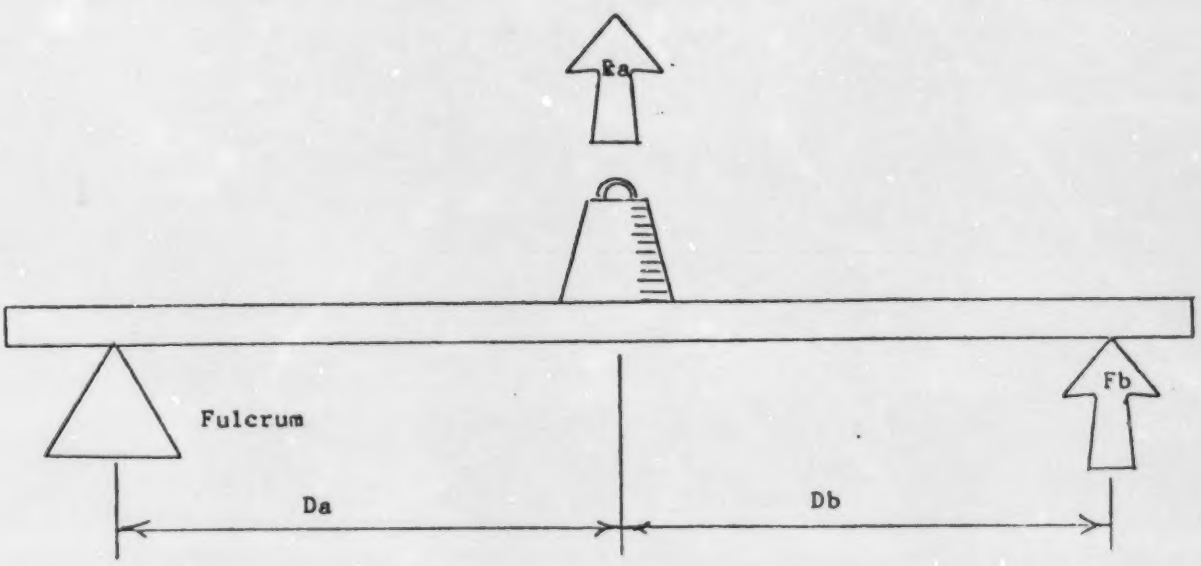


Figure 2 Second-class lever: force, distance, and resistance relationships.

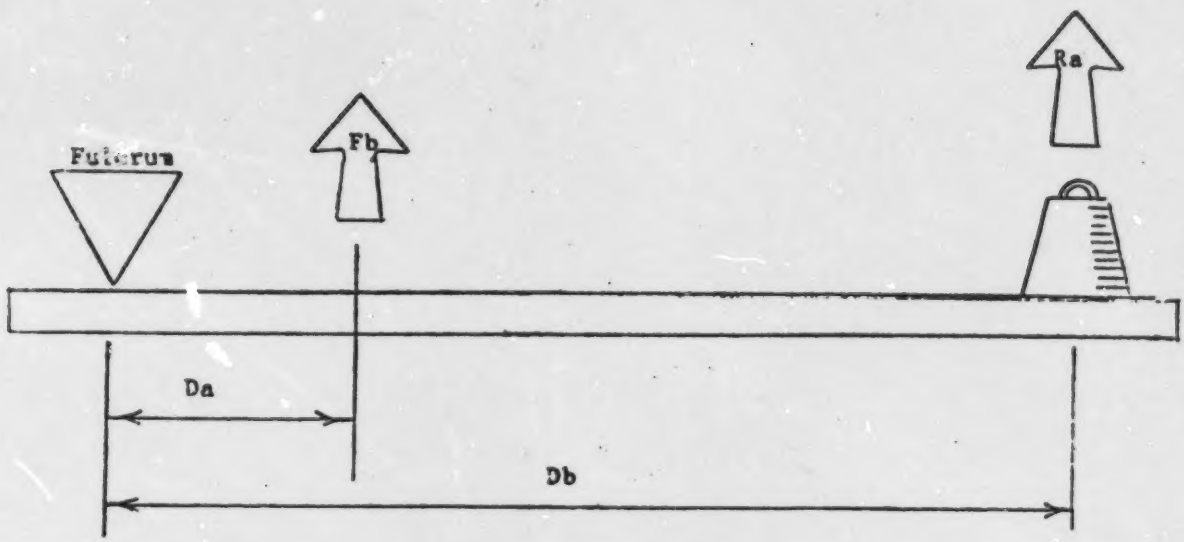


Figure 3 Third-class lever: force, distance, and resistance relationships.

SOLAR ENERGY FLAT PLATE

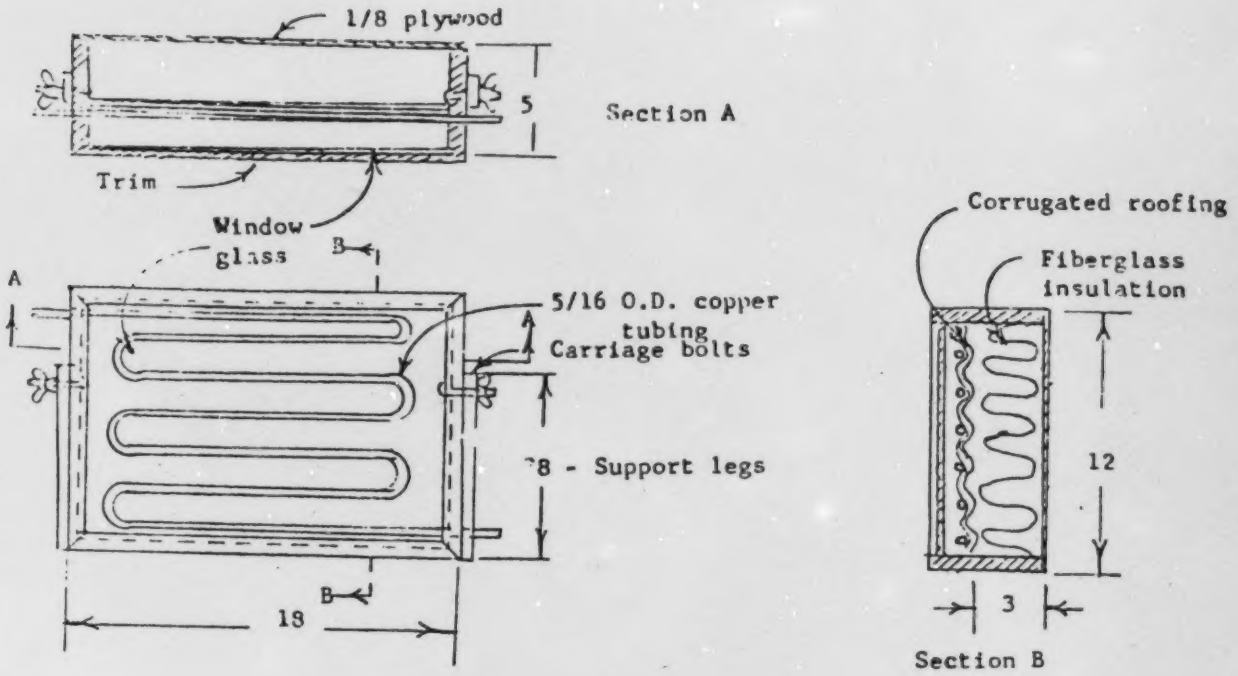


Figure 1. Construction of a flat plate solar collector.

OPERATING PROCEDURE:

1. Locate the thermosiphon system in direct sunlight.
2. Place the bucket on a stand raising it two feet above the solar collector panel (Figure 2).
3. Fill the bucket with water, submerging the return outlet.
4. Suspend a thermometer in the bucket and record the temperature every 30 minutes, on chart below.

	TIME (minutes)					Percent Change			
	0	30	60	90	120	30	60	90	120
TEMPERATURE									

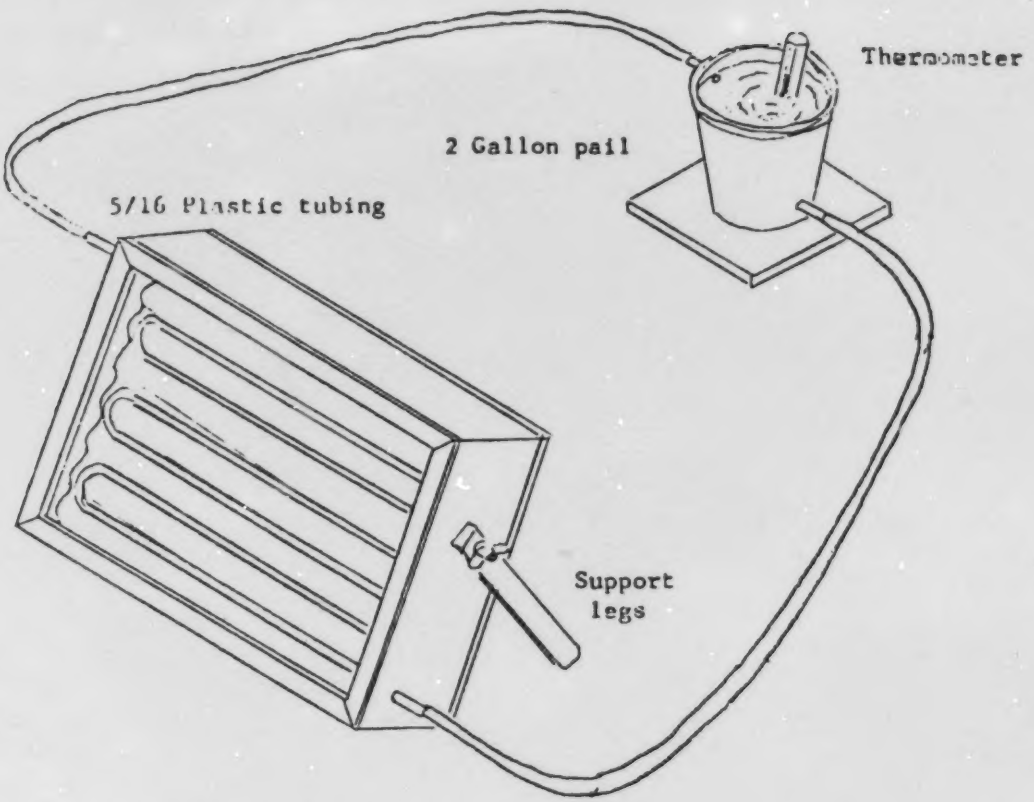


Figure 2. Solar Collector Panel and Reservoir Connections.

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CONSTRUCTION. The project is powered by two solar cell modules, made up of six silicon solar cells. The solar cells measure 2 cm x 2 cm and produce .45 V at 100 mA[1]. The modules produce 2.7 V nickel cadmium battery (AA size) when placed in bright sun for 10 hours.

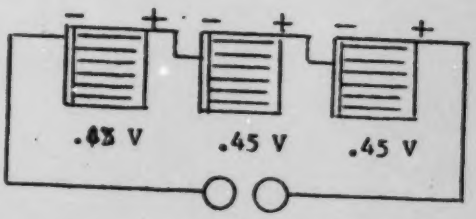
CELL MODULES. The two modules are comprised of three solar cells each, connected in series; the completed modules are connected in series, producing a "solar array" of six solar cells.

1. Identify the positive and negative terminals of each solar cell. The positive side of the cell appears as a solid silver color, while the negative terminal, represented by a single strip at the edge of the solar cell, is located on the opposite (dark blue) side. The negative surface should face the sun when in use.

2. Construct the cell modules by soldering the positive side of one cell to the negative terminal of a second cell. Next, solder the positive side of the second cell to the netative terminal of the third cell (Fig. 3).

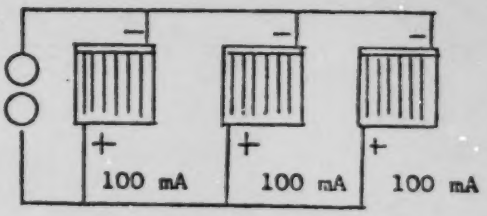
3. Solder a lead wire to the negative terminal of the first solar cell, and another to the positive side of the third cell.

Set the completed modules aside. They will be mounted on a perfboard base to prevent accidental cracking of the fragile cells.



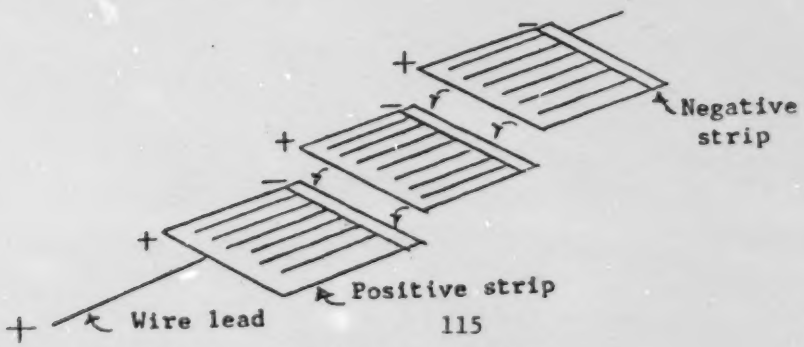
V = .45+.45+.45=1.35V

Figure 1: Series circuit



I_t = 100+100+100=300 mA

Figure 2: Parallel circuit.



BATTERY HOLDER. The project can be constructed on a 3-1/2" x 3-1/2" piece of perfboard. The battery is held in place by two no. 16 wire spring clips, which also serve as the battery's terminal connection.

1. Using pliers, bend the ends of the clips so they will press tightly against the battery terminals. Secure the spring clips to the perfboard with two #2-56 screws and nuts.

2. To provide additional security for the battery, place double-sided tape on the perfboard.

3. Solder a wire lead to each of the spring clips.

4. Solder the cathode end of a blocking diode to the positive battery spring clip wire. The diode will prevent the battery from discharging when no sunlight is available or when the battery has been completely charged. Most general purpose switching diodes (1N645) will function in this project.

MOUNTING THE MODULES.

1. Carefully mix quick-set epoxy and place a small portion on the perfboard.

2. Run the lead wires of the solar modules through holes in the perfboard, then very gently press these units into place. Be careful. Too much pressure may crack the cells.

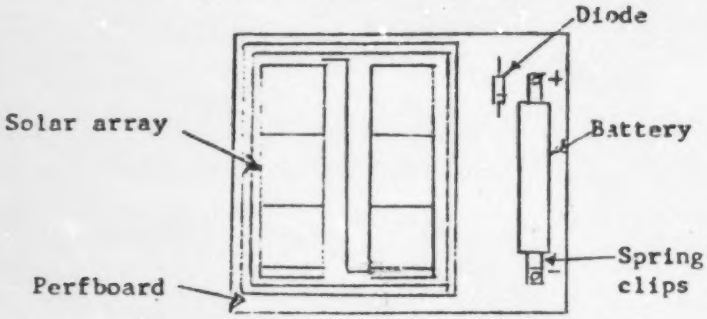
3. Solder the positive lead wire of one solar module to the negative lead wire of the other unit (series connection).

4. Solder the positive lead wire of the second solar module to the positive end of the diode.

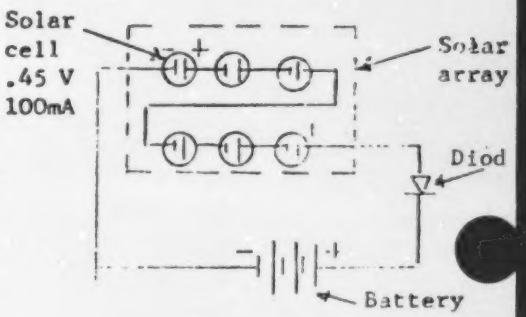
5. Connect the remaining negative lead wire of the cell module to the negative spring clip battery terminal.

6. To protect the solar cells, a 2-3/4" x 2-1/8" x 1/8" thick piece of plexiglass may be epoxy bonded to a small wood frame placed around the cell modules. Although not required for operation, the plastic cover will protect the modules from accidental damage.

OPERATING THE CHARGER. To recharge the ni-cad battery, place the solar trickle charger in direct, bright sunlight for a minimum of 10 hours. Solar radiation is best between 10 A.M. and 2 P.M. The battery may be left in the unit without damage occurring, since the diode will prevent the battery from discharging when the solar cells are not producing maximum output.



Component View



Schematic

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CONSTRUCTING A SOLAR COOKER

The backyard solar cooker described here is simple in concept and easy to build; all it takes is a sheet of reflective material mounted so that it focuses the rays of the sun on a spit. You will need the following materials:

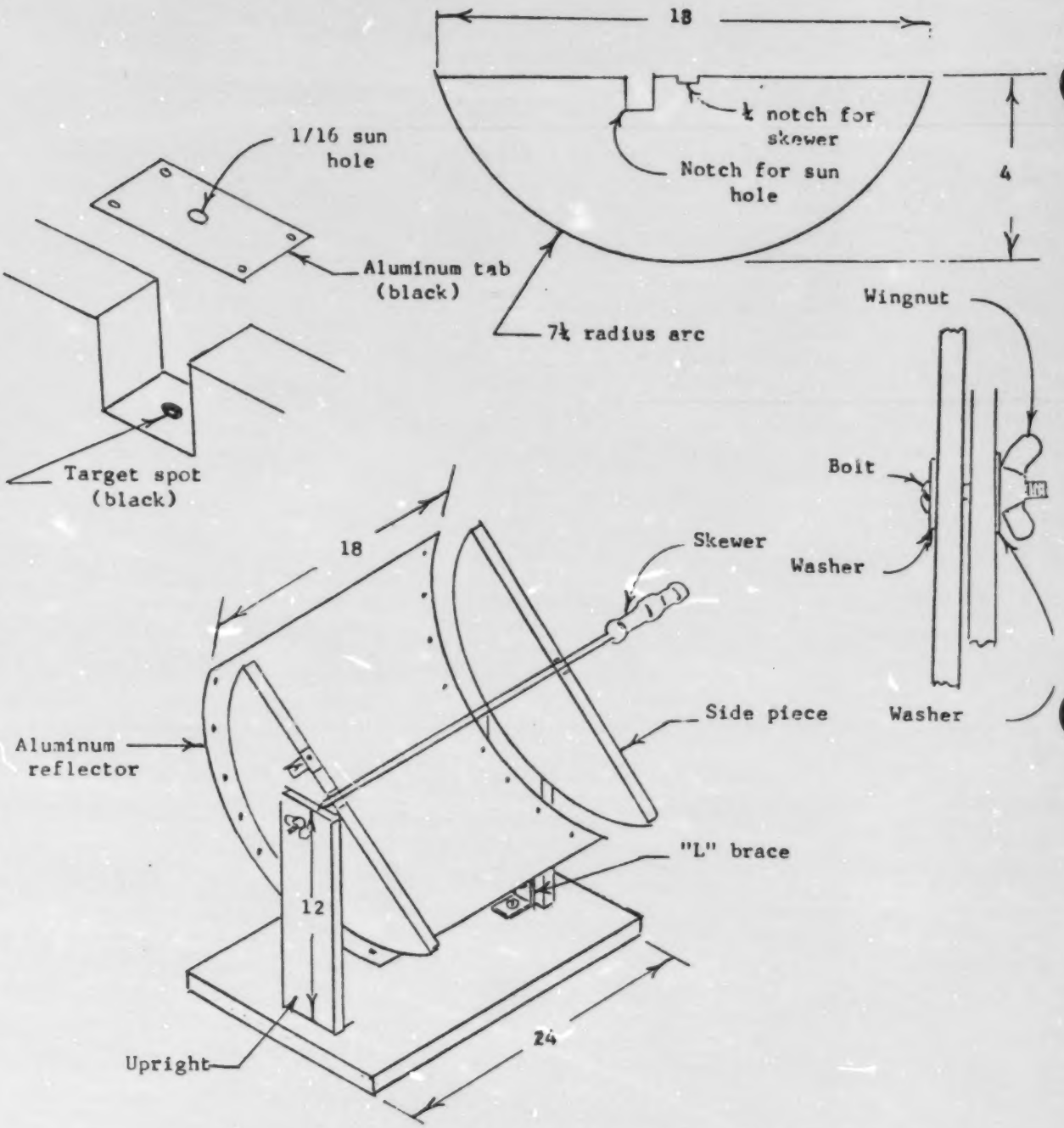
2 feet of 1 x 3 clear pine for uprights
2-1/2 feet of 1 x 6 clear pine for side pieces
2 feet of 1 x 10 clear pine for base
two 2-1/2-inch bolts with wing nuts
four washers to fit the bolts
one 16 by 18-inch piece of reflective sheet aluminum
two dozen 1/2-inch aluminum brads.

The reflector is designed so that the sun's rays will focus along a line where the cooking spit is located. For proper focus, it is important that the shape of the side pieces and positioning of the spit holes follow the given dimensions precisely. Also take care to protect the mirror finish on the aluminum by taping tissue paper over it during assembly.

To construct the reflector unit, first mark and cut out the curved side pieces and plane and sand them to shape. Clamp the pieces together when shaping so that they will be identical. Next, bend the aluminum to fit the curve of the side pieces. Work carefully to avoid creasing the sheet and be sure that the shiny side is on the inner side of the curve. Clamp the side pieces 18 inches apart on a level surface with the curved edges up. Then use the brads to tack the aluminum to the side pieces.

Assemble the rest of the cooker as indicated in the diagram. An old rotisserie skewer or a 1/4-inch square steel rod filed to a point at one end will make a serviceable spit. Note that the notches in the side pieces should be square to hold the spit in position.

While in use, the reflector must point directly a the sun. To maintain this orientation, the tilt of the reflector and the position of the cooker should be adjusted from time to time. A small sun alignment hole is built into one of the side pieces as an aid in aiming the reflector. When rays of the sun impinge directly on the target spot, the cooker is in alignment. After the entire cooker is assembled, test it on a sunny day to make sure the alignment hole is properly located. It can be adjusted by shifting the aluminum tab. Choose a clear, sunny day for cooking (a strong sun is more important than outside temperature). Wrap the food in aluminum foil, dull side out, and turn the spit occasionally. The foil keeps grease from dripping and enhances heat buildup.



SOLAR COOKER

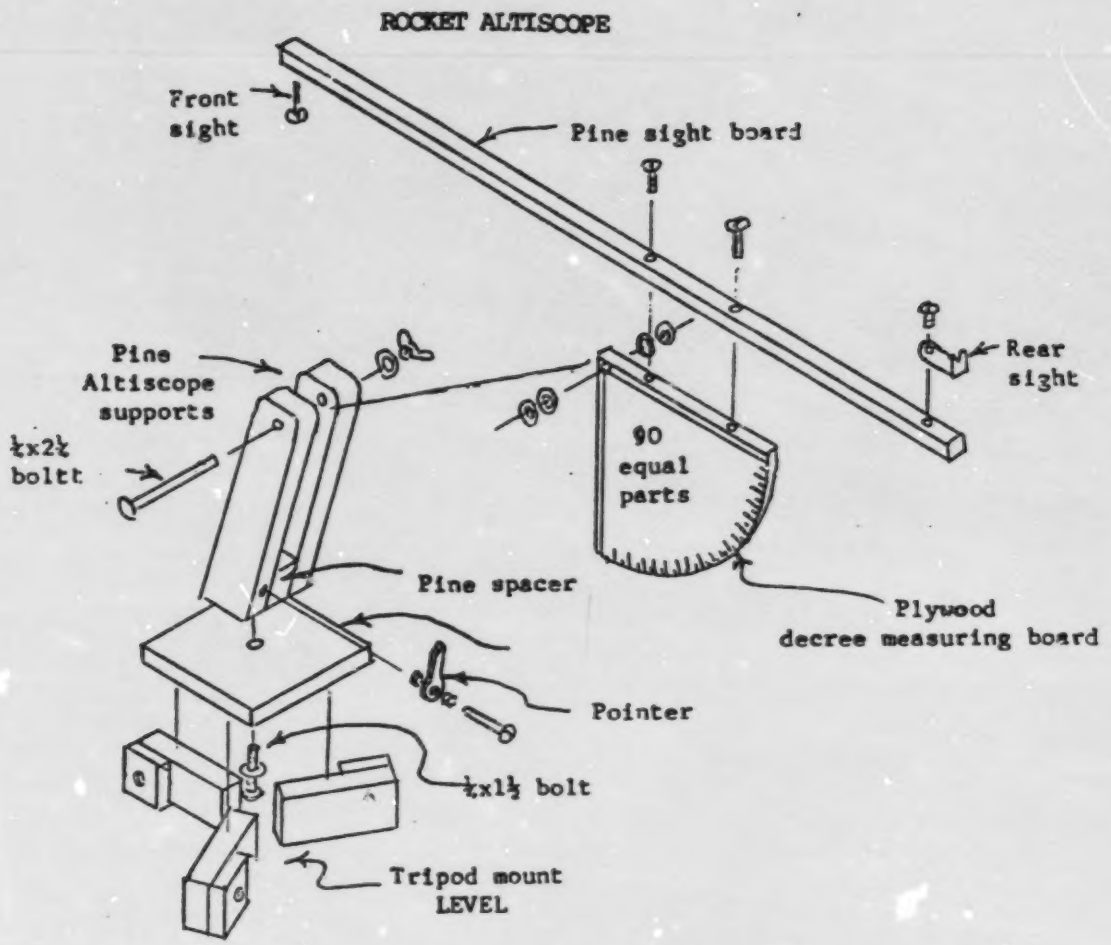


Figure 1. Exploded view of rocket altiscope.

Assemble the altiscope support as shown in Figure above. Before assembling, drill the holes for the mounting bolt and cut a 10° miter at the bottom of each support piece. When the spacer is inserted, the 3/4" dimension should be used to provide clearance for the measuring board between the support legs. Use glue and finishing nails to assemble.

Drill holes through the base and the altiscope support spacer, and fasten with one of the machine bolts. Cut a pointer from sheet metal and attach it to the support as shown in figure above. Note use of nut as a spacer to make pointer stand away from support.

Assemble and drill the tripod mounting legs (use scrap lumber for the 1-1/2" x 1-1/2" squares), then glue them to the base. Finishing nails may be driven through the base into the tripod mounts for a more secure fastening, if desired.

Attach the sighting and measuring board unit to the support, using the carriage bolt. Note use of two washers on each side of measuring board as spacers.

Mount entire assembly on a post or tripod. When in use, the instrument must be level for accurate readings.

OPERATING PROCEDURES:

1. Measure the distance from the altiscope to the launch pad. A recommended distance would be 500 feet. This distance is called the baseline, as shown in Figure 2.

2. Upon launching of a rocket, follow the rocket to its highest altitude using the altiscope.

3. Read the indicated angle on the altiscope scale. Find the tangent of that angle in the Tangents Table (Figure 3).

4. Once you have the tangent of the angle and the baseline, the altitude can be found using the formula:

Rocket Altitude = Tangent of Angle x Baseline.

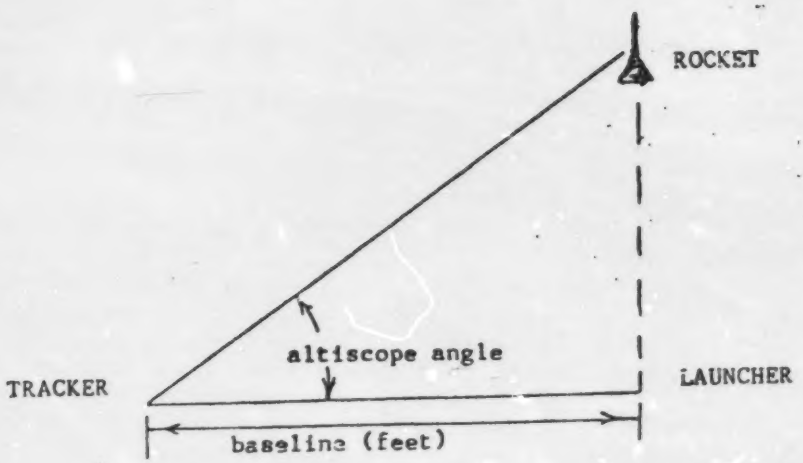


Figure 2 Method used for tracking the rocket with the altiscope.

ANGLE	TAN.	ANGLE	TAN.	ANGLE	TAN.
1°	.02	29	.55	57	1.54
2	.03	30	.58	58	1.60
3	.05	31	.60	59	1.66
4	.07	32	.62	60	1.73
5	.09	33	.65	61	1.80
6	.11	34	.67	62	1.88
7	.12	35	.70	63	1.96
8	.14	36	.73	64	2.05
9	.16	37	.75	65	2.14
10	.18	38	.78	66	2.25
11	.19	39	.81	67	2.36
12	.21	40	.84	68	2.48
13	.23	41	.87	69	2.61
14	.25	42	.90	70	2.75
15	.27	43	.93	71	2.90
16	.29	44	.97	72	3.08
17	.31	45	1.00	73	3.27
18	.32	46	1.04	74	3.49
19	.34	47	1.07	75	3.73
20	.36	48	1.11	76	4.01
21	.38	49	1.15	77	4.33
22	.40	50	1.19	78	4.70
23	.42	51	1.23	79	5.14
24	.45	52	1.28	80	5.67
25	.47	53	1.33		
26	.49	54	1.38		
27	.51	55	1.43		
28	.53	56	1.48		

MECHANICAL TRANSMISSION

MATERIALS NEEDED:

1 ten-speed bicycle
1 piece white adhesive tape
1 working stand

GENERAL PREPARATION:

Set up a ten-speed bicycle on a working stand so that the pedals will crank. Wrap a piece of white tape around the rear wheel at any point.

Count the number of teeth on the front and rear sprockets. Record this data in the gear ratio charts below. Calculate the circumference of the 27" bike tire.

Circumference = 27" x pi (3.1416)

PROCEDURE A: GEAR RATIOS:

1. Adjust the gear levers to obtain first gear.
2. Turn the pedals by hand and record the following information on the gear ratio charts below.
   a. Number of tire revolutions for each revolution of the pedal.
   b. Number of pedal revolutions for each five tire revolutions.
3. Collect the data for each of the remaining nine gears and complete the gear ratio charts. Use fractions to show portions of a revolution.
4. Compute the gear ratios for each of the 10 wheel and pedal sprocket combinations. The ratio is found as follows:

Gear Ratio = Pedal Sprocket/Wheel Sprocket

GEAR RATIO CHARTS

Number of pedal revolutions per rear tire revolution.

SMALL Front Sprocket	LARGE Front Sprocket
1st	3rd
2nd	5th
4th	7th
6th	9th
8th	10th

Tire Revolutions.

(NUMBER OF TEETH ON WHEEL SPROCKETS)

Number of teeth on pedal sprocket	1st	2nd	4th	6th	8th
3rd					
5th					
7th					
9th					
10th					

Number of tire revolutions per one pedal revolution.

GLOSSARY

Absolute zero--The temperature at which all molecular motion stops (no heat remains). On the regular Fahrenheit scale, absolute zero is -460°F.

AC--Alternating current.

Acceleration--An increase in the speed of an object.

Accelerator--Device (usually a foot pedal) that controls the throttle valve in a carburetor.

Accumulator, Hydraulic--An auxiliary storage space for hydraulic fluid under pressure. Used to dampen out pulsations or pressure surges that could cause vibration and uneven operation of hydraulic devices.

Acid--A substance containing hydrogen that can be chemically replaced with metals to form salts; a substance which dissolves in water with the formation of hydrogen ions.

Acid rain--Rain containing an unusually high quantity of acid. Acid rain usually results from high concentrations of sulfur dioxide (SO_2) in the air.

Actuator--A fluid power device that changes fluid power to either rotary, linear, or reciprocating motion.

Air cleaner--Device that removes dust and other contaminants from air before the air reaches the carburetor.

Air foil--A surface designed to produce a reaction from the air.

Air fuel ratio--Proportion of air (measured in pounds or volume to fuel (measured in same unit as air) that makes up the engine fuel mixer.

Allowance--How much larger or smaller a part may be and still work satisfactorily.

Alkalies--A substance to neutralize acids and form salts.

Alternating current--Current that alternately changes polarity (direction). The electrons flow in one direction, then reverse.

Alternator--An electrical device that uses stationary conductors and rotating magnet to generate alternating current.

Ammeter--An instrument used to measure the amount of current in a circuit.

Ampere (A)--A unit of measurement to the rate of electrical current flow.

Anaerobic--Occurring in the absence of free oxygen.

Analysis--Separation into the parts or elements of which a thing is composed.

Anemometer--An instrument for measuring the force or speed of the wind.

Anode--Positive terminal of a battery.

Antenna--Device for radiating or receiving radio signals.

Anthracite--A hard glossy coal that burns without much smoke.

Arcing--Electric current leaping the gap between two electrodes or conductors.

Armature--Revolving part of an electric motor or generator.

Assembly--A unit fitted together from manufactured parts. A unit of matter. It is made up of protons, neutrons and electrons.

Atmospheric pressure--The pressure produced by the weight of the blanket of air surrounding the earth: 14.7 pounds per square inch.

Atom--The smallest particle of an element that can retain the properties of the element and take part in a chemical reaction.

Atomic energy--See nuclear energy.

Axis--A center line that passes through an object about which it could rotate.

Bacteria--Any of the microscopic group of plants used in the fermentation process.

Ball Bearing--An antifriction device composed of an outer and inner hardened steel race (supports) separated by a number of hardened steel balls.

Battery--A group of two or more cells connected together.
Bearings--Devices that reduce friction between moving surfaces.
Bevel--An angle that is not at right angles to another surface or line.
BHP--Brake horsepower. Measurement of the actual power produced by an engine.
Biochemistry--Chemistry dealing with the processes of organisms.
Biodegradable--The natural decomposition of organic materials.
Biomass--Any form of living matter, such as plants and animals.
Bituminous--A type of coal which when heated yields a considerable amount of a highly volatile mixture of hydrogen and carbon.
Block--Part of the engine that contains the cylinder(s).
Bore--The diameter of a cylinder.
Boyle's Law--The volume of a gas varies inversely with the pressure applied to it, provided the temperature remains constant.
Breaker arm--Movable arm on which one of the breaker points is mounted.
Break-in--Period of operation when new or rebuilt parts are worn to the correct fit.
Breeder reactor--A nuclear reactor that is fueled by uranium-238 and plutonium. The fissioning of the plutonium releases neutrons that strike the uranium and convert it into plutonium. The rate at which plutonium is produced is greater than the rate at which it is used.
British thermal unit (BTU)--The amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.
Cable--Strands of wire twisted into a single unit. An electrical conductor consisting of a number of single wire conductors, insulated from each other, that have been twisted into a single strand..
Caloric value--Pertaining to the amount of heat given off when a substance is burned.
Calorie--The metric unit of measurement for heat energy. It is the amount of heat needed to raise the temperature of one cubic centimeter of water one degree Celsius.
Cam--A device on a rotating shaft which converts rotary motion to reciprocal motion.
Camshaft--Shaft in the engine that opens and closes the valves.
Capacitive discharge (CD) system--A solid-state ignition system that eliminates the use of breaker points.
Capacitor--A device that stores an electrical charge. It can be discharged as needed.
Capacitor-start motor--A single-phase induction motor that uses a capacitor to provide high starting torque.
Carbon monoxide--A deadly gas formed by the incomplete combustion of hydrocarbons. It is colorless, odorless, and tasteless and is found in the exhaust of internal combustion engines.
Catalyst--A substance that speeds up a chemical reaction without itself being changed in the process.
Catalytic converter--Emission control device in exhaust stream that oxidizes gases by chemically treating them after combustion.
Cathode--The negative pole or terminal of a battery.
Centrifugal force--A force that causes a rotating object to move away from the center of rotation.
Chain reaction--A series of events in which each event initiates the succeeding one.
Charcoal--A dark porous carbon made by partly burning wood with only little air available.
Charles' Law--The volume of a gas varies directly with the temperature applied to it, provided the pressure remains constant.

BEST COPY AVAILABLE

Chemical energy--Energy produced by chemical changes. Chemical energy is the source of energy for all living things.
Chemical Explosive Engine--Compact source of high power for a short time. Combustion gases from burning propellants drive a turbine harnessed to do the required work.
Choke--A reduced air passage, usually consists of a valve in the carburetor air horn to cut down volume of air for cold starts.
CID--Cubic inch displacement.
Circuit--The various conductors forming a path for electron flow from a source and then back to it.
Circuit breaker--A protective device in the form of a relay which opens the circuit in case of an overload.
Clearance--Space between two parts.
Clockwise--Rotation in the same direction as the hands of a clock.
Clutch--A transmission device that controls the transfer of power from an input shaft to an output shaft.
Coal--See fossil fuels.
Cogeneration--Using a single energy source for two useful purposes. Example: Steam run through turbines for generating electricity can also be used for heating.
Coherence--A characteristic of laser beams: their light waves have almost identical lengths.
Coke--A fuel made by baking bituminous coal in a closed oven to drive off gases and other elements.
Combustion--The burning process that occurs when a material is ignited.
Combustion chamber--Area where burning occurs.
Compound--Made up of two or more parts.
Compression--Pressure applied to a gas, which reduces its volume.
Compression Ignition Engine--Diesel engine.
Compression ratio--Relationship between the volume of the cylinder when the piston is at bottom dead center and the volume of the cylinder when the piston is at top dead center.
Concave surface--Surface having a curved depression.
Concentric--Sharing a common center point.
Condenser--Device that temporarily absorbs and stores a surge of electric current. Also, in a steam power plant, a unit that recovers water from exhausted steam.
Conduction, thermal--The movement of heat through a substance.
Conductors--Materials that easily transmit (conduct) electricity.
Conifer--A class of cone bearing trees, mostly evergreens.
Contour--The outline of an object or figure; particularly a curved or an irregular outline.
Contaminants--Something that will soil, stain, or infect by contact or association.
Convection--The movement of heat through air, water, or other fluids. The heated fluid carries the heat from one place to another.
Convex surface--Rounded surface raised on an object.
Coolant--Fluid used in the cooling system of an engine.
Core--The heart of a nuclear reactor.
Coulomb--The basic unit of measurement of electricity. It is 6.28×10^{18} electrons.
Counterbalance--Weight attached to a moving part to bring it into balance.
Counterclockwise--Rotation opposite the movement of the hands of a clock.
Cracking--The process of further refining crude oil through the use of a catalyst, thereby producing additional gasoline.
Crankshaft--Engine's main shaft with throws (offsets) to which the connecting rod(s) are attached. It runs the length of the crankcase.

Cryogenics--The science that deals with the properties and behavior of materials at very low temperatures.
Cubes--Cubic inch displacement of an engine.
Current, electric--The movement of electrons through a conductor.
Cycle--Sequence of events.
Cylinder--A round hole bored to receive a piston.
Cylinder head--A detachable metal portion of an engine bolted on top of cylinder block.
DC--Direct current.
Decay--A term used to express a gradual decrease or breakdown in a composition.
Decibel--Unit for measuring sound.
Degree--1/360th of a circle.
Diesel engine--An internal-combustion engine that burns diesel oil to produce heat. Pressure inside the combustion chamber causes the fuel to ignite.
Diffuser--Device or design feature that slows velocity of incoming air while increasing its pressure.
Direct current--Current that flows through a conductor in only one direction.
Displacement--Volume of a cylinder displaced by the movement of the piston from bottom dead center to top dead center.
Distributor--Acts as a rotary switch, sending high voltage electricity to the spark plugs.
Drive fit--The two mating parts are literally hammered together.
Dry cell--A nonliquid battery cell.
Dynamic balance--Condition when the weight mass of a revolving part is on the same plane as the center line of the object.
Dynamometer--A device used to measure the power produced by an engine or motor.
Earth warming--The long-range warming of the earth due to increased levels of carbon dioxide in the air.
Eccentric--Circles and arcs not on a common center.
Efficiency--The percentage of available energy converted into usable energy.
Electrical circuit--A system of conductors and electrical devices through which an electrical current moves.
Electrical energy--The motion of electrons. Electrical energy is measured in joules.
Electrolyte--A current-carrying solution, such as is used in storage batteries and fuel cells.
Electromagnet--A magnet consisting of an iron core wrapped with a current-carrying wire.
Electromagnetic waves--Waves of electrical energy that travel through the atmosphere and outer space. Electromagnetic waves include gamma rays, X-rays, microwaves, visible and invisible light, and radio waves.
Electron--A negatively charged particle of an atom.
Electromotive Force--Force that causes an electric current to move in a conductor. Unit of measurement is called a VOLT.
Emery cloth--Cloth with emery abrasive cemented to its surface, used to clean and polish metal.
EMF--Electromotive force.
Emission control--A system of devices on automobile engines to reduce the amount of pollution produced by the engine.
Energy--The ability to do work or the capacity to produce motion, heat, or light. In the customary system, energy is measured in foot-pounds, British thermal units, and joules. In the metric system, energy is measured only in joules.

Energy conversion--The process of changing energy from one of its six forms to another.

Energy system--A system for controlling energy, it includes the original source of energy, all the conversions and transmissions the energy undergoes, and the eventual use of the energy.

Energy transfer medium--A substance (gas or fluid) through which energy can be transmitted.

Engine--A device that converts any form of energy into mechanical energy.

Enzyme--A complex protein product of living cells that induces chemical reactions in plants and animals.

ET--Elapsed time. The time it takes a dragster to complete a measured 1/4 mile run.

Evolution--The process of working out or developing.

Exhaust system--Series of pipes and tubes that get rid of the engine's waste gases.

Exhaustible energy sources--Sources of energy that cannot be replaced after use. These sources include fossil fuels and uranium.

Expander--Steam engine.

External combustion engine--A heat engine that uses heat and pressure produced outside of the engine.

Fallout--Radioactive particles resulting from a nuclear explosion and descend through the air.

Fantail--A fan shaped tail or end.

Fermentation--Chemical decomposition of an organic substance by enzymatic action often forming a gas.

Fiber-optic system--A communication system that uses semiconductor lasers and strands of flexible glass for transmission.

Fibrous--A thread like structure giving an element texture or substance.

Field magnets--Magnets that make up the field of a motor or generator.

Fission--The splitting of atomic nuclei to release energy.

Fissured rock--A rock with a crack or cracks running through it.

Flooding--Condition in which an excessive amount is discharged into the cylinders. Starting is very difficult or impossible.

Fluid--Any liquid or gas.

Fluid power--The use of fluids under pressure to control and transmit power. Fluid power includes the use of both gases (pneumatics) and liquids (hydraulics).

Follower--A roller or follower which rides on a cam surface and follows the contour of the cam.

Force--Any push or pull on an object. Force is measured in pounds or newtons.

Formula--A prescribed method; a recipe.

Fossil fuels--Fuels that developed over millions of years from dead plants and animals. Fossil fuels include coal, oil (petroleum), and natural gas.

Free piston engine--Power plant with two pistons freely moving back and forth in a casing with a multi-diameter cylinder. Expanding gases of combustion are directed to a turbine which powers a compressor that transmits power to drive wheels.

Fresnel lens--Lens with surface engraved with a great number of concentric circular lines.

Friction--The resistance to motion produced when two objects rub against each other. Friction produces heat energy.

Fuel--Any substance that can be burned, fissioned, or used in a fusion reaction to produce heat.

Fuel cell--A device that produces electricity from a chemical reaction between hydrogen and oxygen.
Fuel rod--A tube of nuclear fuel pellets.
Fuse--An electrical device that protects a circuit from excessive current flow.
Fusion--The fusing (combining) of atoms to release energy.
Galvonometer--Instrument for detecting or measuring a small electric current.
Gas turbine--A jet-type engine used to provide rotary motion for vehicles and electrical generators.
Gasohol--A mixture of nine-tenths unleaded gasoline and one-tenth ethyl alcohol.
Generator--A device that converts rotary motion into electrical energy.
Geopressure gas--Natural gas found dissolved under high pressure in brine (salt water) deep within the earth.
Geothermal power--Tapping earth's heat and directing it to a power plant to generate electricity or use it to heat buildings.
Geyser--A hot water spring that periodically shoots into the air.
Governor--A device that automatically regulates the speed of an engine. It is usually used on small engines.
Gravity--The attraction exerted by a large body (for example, the earth) for objects on or close to its surface.
Greenhouse effect--The effect that carbon dioxide has on the temperature of the earth. Carbon dioxide acts like greenhouse glass to trap solar heat in the atmosphere and warm the earth.
Ground--An electrical connection that permits electricity to return to its source, in automobiles, the ground is the automobile frame.
Ground Fault Circuit Interrupter (GFCI)--A circuit breaker that protects against shock by breaking the circuit when an unintentional ground occurs.
Hardwood--Wood from a broad-leaved, usually deciduous tree as distinguished from that of a conifer.
Heat--The motion of atoms or molecules. Heat is present wherever there is motion.
Heat engine--A device that converts heat energy into mechanical energy.
Heat exchanger--A device that transfers heat from one fluid to another.
HERF--A term used to denote High Energy Rate Forming, a technique that utilizes the energy in compressed gases, explosives or electricity to shape metal.
Hertz--Electrical cycles per second, in the United States, alternating current is 60 hertz.
Hole--Positive charge. Space left by removed electron.
HP--Horsepower. Unit of power that is the measurement of ability to do work. Work required to lift 33,000 pounds one foot in one minute. 746 watts equals one horsepower.
Hydraulic energy transfer system--A system that uses fluid as the substance to transfer energy from one point to another in the system where the energy in the pressurized fluid is converted into mechanical energy to perform the desired work.
Hydraulics--The use of liquid under pressure to produce motion.
Hydrocarbons--Compounds consisting of combinations of carbon and hydrogen. Hydrocarbons include the fossil fuels and such biomass materials as wood.
Hydroelectric energy--Electrical energy produced from falling water. Water is collected behind dams and used to rotate a turbine.
Hydrogen--The simplest element, consisting of a nucleus of one proton orbited by a single electron.

Hydrolysis--A chemical decomposition involving the addition of water.
Hydrometer--Device for determining the specific gravity of electrolyte in a battery. Test determines state of charge of battery.
Hypersonic--Moving at speeds equal to or in excess of five times the speed of sound.
Ignition--The combustion of a fuel mixture in the combustion chamber.
Induction--The process of transmitting electrical energy from one circuit to another through the building and collapsing of a magnetic field.
Induction motor--A type of electric motor in which the armature receives current through electromagnetic induction rather than through a direct electrical connection.
Inertia--The tendency of an object at rest to remain at rest, and of an object in motion to continue in motion.
Inexhaustible energy sources--Energy sources that will always be available. These sources include solar energy, hydroelectric energy, tides, ocean thermal energy, solar salt ponds, and geothermal energy.
Inflammability--The ability to be kindled.
Input-output--The ratio of energy input to a device as compared to the work achieved.
Insulation--Material used to reduce the flow of heat.
Internal-combustion engine--A heat engine in which the heat and pressure are produced inside the engine.
Isotopes--Different atoms of the same element. The difference is in the number of neutrons in the nucleus. All isotopes of a single element have the same number of electrons.
Jet engine--An internal-combustion engine that produces linear motion through the principle of jet propulsion.
Jet propulsion--The principle of Newton's third law of motion. For every action there is an equal and opposite reaction. Escaping gases reduce pressure at one end of cylinder, producing thrust (force) at the other end.
Joule (J)--The customary unit of measurement of electrical energy and the metric unit of measurement of mechanical, thermal, and electrical energy. One joule equals .7376 foot-pound and .0009485 British thermal unit.
Key--A small piece of metal inserted between a shaft and a hub to prevent a gear or pulley from rotating on the shaft.
Keyway--Slot or recess cut in a shaft that holds the key.
Kilowatt--1000 watts
Kinetic energy--Energy in motion. All energy performing work or producing power is kinetic energy.
Laser--A concentrated beam of light that travels in a very narrow straight path.
Law of Conservation of Energy--Energy cannot be created or destroyed; the amount of energy in the universe is fixed. However, energy can be changed from one form to another.
Lead acid cell--Secondary cell that uses a lead peroxide and sponge lead for plates and sulphuric acid as its electrolyte.
Light energy--The visible part of radiant energy. Light consists of electromagnetic waves traveling through space.
Ligneous--Woody.
Lignite--A brownish black soft coal of a slightly woody texture.

Linear motion--Motion in a straight line, such as produced by a jet engine or rocket.
Linkage--Movable elements (rods, bars, wires, springs, etc.) that connect one part with another part.
Liter--Metric measurement of capacity or volume.
Longitudinal--Relating to lengthwise dimension.
Lubricant--Material (usually with a petroleum base) placed between moving parts to reduce friction.
Machine--A device that changes the relationship between force and speed (distance per unit of time). Simple machines include the lever, wheel and axle, pulley, inclined plane, wedge, and screw.
Mach number--Ratio of speed of a body to the speed of sound in surrounding atmosphere.
Magma--Molten rock.
Magnetism--The invisible force of a magnet which causes it to repel and attract.
Magnetic field--The area around a magnet or current-carrying wire in which magnetic attraction or repulsion takes place.
Magneto--A small, self-contained electric generating system.
Magnetohydrodynamic generator--Source of large blocks of electrical power, produced by passing high-temperature gas through a magnetic field.
Malfunction--Improper operation.
Mechanical advantage--An increase in force or speed (distance per unit of time) gained through the use of a machine.
Mechanical energy--The energy of motion, the most common and visible form of energy. It is measured in foot-pounds or joules.
Mega--Prefix meaning one million times.
Meter (m)--The metric unit of measurement of length. One meter equals 39.37 inches.
Methanol--A clean-burning liquid fuel made from wood or plants, including waste wood and vegetable products.
Metrication--Conversion of English system of measurement to the metric system.
Micro--Prefix meaning one millionth of.
Microwaves--High-energy electrical waves used to transmit electrical energy through the atmosphere and outer space.
Mile--Unit of measure equal to 5280 feet.
Molecule--The smallest particle of a chemical compound that retains the properties of the substance.
Momentum--The measured force of a moving body. The faster a body moves, or the greater its weight, the greater its momentum.
Motor--An electical-or fluid-operated device that produces rotary motion.
MPH--Miles per hour. Way of specifying speed based on distance traveled in one hour.
Natural gas--See fossil fuels.
Naval stores--A group of products derived from the pine tree such as turpentine, rosin, and pine oil.
Network--Two or more units connected in parallel or series.
Neutron--A neutral particle that makes up part of the nucleus of an atom.
Newton (N)--The metric unit of measurement for force. One newton equals .2248 pounds.
Nuclear battery--A type of battery that produces electrical energy from radioactive materials.
Nuclear energy--Energy produced by reactions in the nuclei of atoms.

Nuclear fission--Occurs when uranium is used to produce heat through a chain reaction.
Nuclear reactor--A device in which a fission or fusion reaction is started, continued, and controlled.
Nuclear wastes--The by-products of a nuclear reaction, usually very radioactive and dangerous.
Nucleus--The center of an atom, consisting of protons and neutrons. (The plural is nuclei.)
Ocean thermal energy--Energy generated by the difference in water temperature between surface and deep ocean water.
Ohm--The unit of measurement of electrical resistance.
Ohm's Law--It takes one volt to force one ampere of current through a resistance of one ohm.
Oil (petroleum)--See fossil fuels.
Oil seal--A material that prevents oil from leaking past a certain point.
Orifice--Opening.
Ozone--A harmful form of oxygen formed when sunlight strikes air containing hydrocarbons and nitrogen oxides. Ozone is a major ingredient of smog.
Parabolic--Shaped like a parabola.
Paraffin--A waxy substance used for making candles and sealing foods.
Parallel circuit--An electrical circuit in which current flows in more than one path.
Particulates--Tiny particles of matter released into the air by burning fossil fuels.
Pascal (Pa)--The metric unit of measurement for fluid pressure. One pascal equals .000145 pound per square inch.
Permanent magnet--Any of a number of materials that retain magnetism over a long period of time after they have been magnetized.
Petroleum--See fossil fuels.
Petroleum equivalency--The heat an equivalent amount of petroleum would give off.
Photoelectric--Pertaining to the process by which light energy is converted directly into electrical energy, usually through the use of a photoelectric cell.
Photosynthesis--The conversion by plants of sunlight, carbon dioxide, water, and nutrients into food and plant material.
Piston--A cylindrical part, closed at one end, which fits in the cylinder and is connected to the crankshaft by a connecting rod.
Pitch--An up and down (seesaw) movement of a vehicle.
Plasma--A temporary physical condition of gas after it has been exposed to an arc.
Plutonium--A radioactive element found in small quantities naturally and produced from uranium-238 during nuclear fission. It can be used as a nuclear fuel.
Pneumatic energy transfer system--A system that uses air
Pneumatics--The use of air under pressure to produce motion and perform work.
Polarity, electric--The direction of current flow. Current always flows from negative (area of more electrons) to positive (area of less electrons).
Polarity, magnetic--The direction of magnetic lines of force. Around a magnet, the lines of force move from north to south. Inside a magnet, they move from south to north.
Pollution--Any undesirable change in the air, land, or water that harmfully affects living things.

Porosity--The property permitting fluids to pass through an object.
Potential energy--Stored energy, or energy ready or available for use. When used, potential energy changes to kinetic energy.
Power--Energy (work) per unit of time, or work accomplished in a given period of time. In the customary system, power is measured in horsepower, BTUs per hour, and watts. In the metric system, power is measured in watts.
Pressure--A measurement of force determined by the area on which the force is applied. Pressure is force per unit of area. Pressure is measured in pounds per square inch, inches of mercury, and pascals.
Pressure regulator--A device used to reduce and control pressure in pneumatic and hydraulic energy transfer systems.
Pressure relief valve--A valve designed to open at a specific pressure. Prevents pressure in a system from exceeding safe limits.
Primary cell--A device that stores chemical energy. The chemical energy is converted to electricity as needed. Primary cells cannot be recharged.
Proportional--A relationship of equality (ratio) between two similary things. Properly related in measurable characteristics or features.
Proton--A positively charged particle located in the nucleus of an atom.
PSI--Pounds per square inch. The number of pounds of pressure pushing on each square inch of area.
Pump--A device that converts mechanical power into fluid power.
Pyrolysis--A chemical decomposition involving the use of heat to generate gas.
Radiant energy--A form of energy produced by any warm or hot object, such as the sun. It is a combination of light and heat energy. Radiant energy changes to heat energy when it strikes a solid object.
Radiation, atomic--Energy released during changes in the nuclei of atoms. Atomic radiation includes alpha particles, beta particles, and gamma rays.
Radiation, thermal--The transfer of heat by electromagnetic waves through space and air.
Radioactivity--The release of atomic radiation during the disintegration of the nuclei of certain atoms.
Ramjet engine--A jet engine that uses the forward motion of the engine to bring air into the combustion chamber and to compress the air.
Reactor--An apparatus in which a chain reaction is initiated, continued, and controlled.
Reciprocating motion--Back and forth movement, such as a piston moving inside a cylinder.
Rectifier--A component or device used to convert AC to pulsating DC.
Refining--The process of separating a crude substance into purer, useful substances. In crude oil refining, this process is called fractioning.
Regenerator--Element of Stirling engine which alternately accepts and releases heat. Also, element of turbine engine that utilizes hot exhaust gases to heat incoming air.
Regulator--A device to control or adjust a time, degree, amount, or rate of something.
Relay--An electromagnetic device for remote or automatic control of other devices in the same or different circuits.
Relief valve--Valve to relieve pressure build up.
Renewable energy sources--Sources of energy that, with proper management, will be available indefinitely. Renewable sources include wood, plants and waste products.
Reservoir--A storage place for fluid used in a hydraulic system.
Resin--An oily gummy substance soluble in alcohol.

Resistance, electrical--The opposition to current flow through a conductor. Resistance is measured in ohms.
Robotics--The field of study dealing with the construction, maintenance, and use of robots.
Rocket engine--An engine that operates on the principle of jet propulsion and which carries its own supply of fuel and oxygen.
Rotary engine--An internal-combustion engine in which a triangular rotor rotates within a housing. The motion of the rotor rotates an output shaft.
Rotary motion--Circular motion, such as the motion produced at the flywheel of an engine.
SAE--Society of Automotive Engineers.
Safety Factor--Strength provided beyond that needed for safe operation of vehicle or device.
Sandblast--Cleaning an object by means of sand propelled by compressed air.
Seal--Something that secures an opening against unwanted entry.
Secondary cell--A chemical storage cell that can be electrically discharged and recharged repeatedly.
Sedimentation--Material deposited by water, wind, or glacier i.e. sand and gravel and silt.
Seebeck effect--The principle of converting heat energy directly into electrical energy.
Semiconductor--A material that has come of the properties of both insulators and conductors. Semiconductors are the basic materials for solid-state electrical devices.
Series circuit--An electrical circuit that has only one path for current flow.
Shackle--Device used to attach spring to the frame.
Shale--Rock formed of densely packed clay, mud, or silt that easily splits into layers.
Shale oil--A form of oil trapped within a kind of rock called shale.
Shim--Thin material used between two parts to increase clearance.
Short circuit--An accidental bypassing of the normal resistance in an electrical circuit.
Smog--A major form of air pollution produced from sunlight acting on hydrocarbons and nitrogen oxides in the air.
Softwood--Wood from a conifer.
Solar battery--Two or more solar cells grouped together to increase the electrical output.
Solar (photoelectric) cell--A device that converts light into electricity.
Solar energy--Energy from the sun. Solar energy is our most basic source of energy.
Solar heating, active--A solar heating system that collects solar energy and moves it by mechanical means to where it is needed.
Solar heating, direct-gain--The heating of living space directly with sunlight.
Solar heating, indirect-gain--The heating of living space by first heating a thermal mass such as water or masonry. The thermal mass then heats the living area by radiation and convection.
Solar heating, passive--A solar heating system that collects, stores, and transfers heat by natural means. Passive heating systems include both direct-gain and indirect-gain systems.
Solar panel (collector)--A device used in an active solar heating system to absorb solar energy.
Solenoid--A device that converts electrical energy to linear motion.
Sonic--Moving at the speed of sound.
Souping--Modifying engine to increase its power output.

Spark ignition engine--Power plant in which fuel-air mixture is ignited at correct time by an electrical spark.
Spark plug--Provides the electrical spark that ignites the fuel-air mixture in a cylinder.
Static--A stationary charge of electricity either positive or negative in polarity.
Static pressure--Acting by mere weight without current.
Stator--Fixed blade in a turbine. Also, metal frame of an alternator with three stationary windings.
Steam engine--An external-combustion engine that converts the heat and pressure of steam into mechanical energy.
Steam generator--Steam boiler, usually made up of small diameter steel tubing.
Steam turbine--An external-combustion engine used to produce rotary motion. Steam turbines are commonly used to produce electricity and power large ships.
Stirling Cycle engine--An external-combustion engine that operates on the heating and cooling of a gas within a cylinder. This causes a piston to move within the cylinder.
Stroke--The movement of a piston from one end of a cylinder to the other.
Subsonic--Moves through the air at speeds less than the speed of sound.
Superconductor--An electrical conductor that has lost all detectable electrical resistance because its temperature has been reduced below -418°F (-250°C).
Supersonic--Moving at speeds greater than the speed of sound.
Switch--Device for controlling flow of electric current in a circuit.
Synfuels (synthetic fuels)--Liquid or gaseous-fuels made from existing solid fuels. Synfuels are produced from coal, tar sands, and oil shale.
Synthetic--Artificial; man-made.
Tar sands--A form of oil trapped in heavy sand.
Tachometer--Instrument for testing engine speed in revolutions per minute.
Technician--Person doing complex work of a highly technical nature.
Tension--The act of pulling.
Thermal energy--See heat.
Thermal mass--A heat storage material, such as water, masonry, or concrete, used in passive solar heating systems.
Thermal pollution--The release of waste heat into air or water by power plants. This waste heat upsets the delicate balance of nature.
Thermal reactor--Emission control device in exhaust stream that utilizes extremely high temperatures to oxidize gases.
Thermodynamic--The science of conversion of energy from one form to another, and the work that results from or is required to cause the transformation.
Thermoelectric coupling--A device used to generate electricity from a heat source. The coupling uses two different materials joined together. Heat applied at one end produces electricity at the other.
Thermoelectric generator--Device that converts heat energy directly into electrical energy.
Thermosiphoning--The circulation of water by natural convection. Thermosiphoning operates on the principle that as water is heated it expands and rises.
Thermostat--A device that senses and regulates temperature.
Third Law of Motion--A law of nature discovered by Isaac Newton: For every action there is an equal and opposite reaction.
Thorium--A radioactive metallic chemical element.
Thrust--A forward push or force produced by a jet or rocket engine. Thrust is measured, like force in pounds or newtons.

Tidal energy--Energy generated by using the flow of ocean tides.
Tight sand reserves--Natural gas trapped in a type of hard, dense sandstone.
Tolerance--Amount of variation permitted from a specified measurement.
Torque--A twisting or turning effort; also, a measurement of force applied to a radius. Torque is measured in pound-feet or newton-meters.
Transformer--A device that transmits electricity from one circuit to another by induction, changing amperage and voltage in the process.
Transmission--A device that uses gearing or torque conversion to bring about changes in the ratio between engine rpm and driving wheel rpm.
Transonic--Moving at speeds approaching the speed of, and slightly exceeding, the speed of sound.
Turbulence--The quality or state of being agitated.
Universal motor--An electric motor that can operate on either AC or DC current.
Uranium--A radioactive element used as fuel in nuclear reactors.
Vacuum--A pressure below atmospheric pressure. Zero pressure is a perfect vacuum. Vacuums are measured in inches of mercury.
Valve--Device used to open and close an opening.
Velocity--The speed of an object.
Viscosity--The rate at which a liquid flows.
Volt (V)--A unit of measurement of electrical pressure. One coulomb of electricity exerts a pressure of one volt.
Voltaic cell--Battery produced by suspending two dissimilar metals in an acid solution. Chemical energy is converted to electrical energy.
Voltmeter--Meter that measures voltage.
Water flash--Immediate conversion of water to steam caused by a sudden reduction in pressure on heated water.
Watt (W)--The customary unit of measurement of electrical power, and the metric unit of measurement of electrical and mechanical power. One watt equals one joule of electrical energy per second. One watt is also equal to a flow of one ampere at a pressure of one volt. 746 watts equals one horsepower.
W.E.C.S.--Wind Energy Conservation System.
Windmill--A power plant that harnesses the natural energy of the wind.
Wind power--The use of wind to generate electricity or produce motion.
Wind turbine--A rotating device driven by wind and used to drive an electrical generator.
Work--Motion that produces a desired outcome or accomplishment. Work is equal to force times distance and is measured in foot-pounds or joules.
Yaw--Movement right or left away from an intended course by an aerospace vehicle or boat.

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